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OFFICIAL PUBLICATION OF THE PROCEEDINGS, AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS

American Dyestuff Reporter was founded in 1917 and the Textile Colorist and Converter (formerly Textile Colorist) was incorporated with it in January, 1949. Published every other Monday, by the **HOWES PUBLISHING COMPANY, INC.**, 44 East 23rd Street, New York 10, N. Y. **C. R. Howes**, President; **Ernest J. Finan**, Executive Vice-President; **Norman A. Johnson**, Vice-President & Treasurer; **Myron D. Reeser**, Vice-President; **C. Essenbreis**, Secretary.

Telephone SPring 7-9364

AMERICAN
DYESTUFF REPORTER
DEVOTED TO TEXTILE WET-PROCESSING

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AMERICAN
DYESTUFF REPORTER
Volume 46 August 12, 1957 Number 16

ABSORPTION OF WATER BY AND DRYING OF UNTREATED, LAUNDERED, AND USED AND LAUNDERED COTTON AND LINEN TOWELING

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INTRODUCTION

As a result of use and laundering, toweling may undergo changes in properties which in turn affect absorbency and drying. Consequently, the purpose of this study was to determine how the absorption of water by and drying of plain weave cotton and linen toweling were affected by 0, 20, 40, and 60 cycles of laundering only and of use and laundering. The possible relationships of absorption of water to such fabric characteristics as count, thickness, weight, and shrinkage also were examined. In addition, a study was made of the relation of absorption of water by cotton and linen toweling to dry fabric breaking strength.

A few studies have been made of the effects of laundering upon the absorption of water by fabrics (*1, 2, 3, 4, 5, 6*), but no studies of the relationship of laundering or service to drying properties have been found. Some investigations have been made of changes in physical properties of toweling after laundering or service (*4, 7, 8, 9, 10, 11, 12, 13*).

An investigation was made to determine how the absorption of water by and the drying of plain weave cotton and linen toweling were affected by 20, 40, and 60 cycles of laundering only and of use and laundering. After repeated launderings, cotton toweling decreased relatively little in breaking strength and generally took up moisture more readily than linen toweling during the early part of the absorption period. However, when the toweling absorbed water to a point approaching saturation, linen toweling generally took up more moisture than cotton toweling. The linen toweling also had the advantage of increasing in absorbency with increasing laundering up to a certain point, after which it decreased in absorbency as the fabric decreased in weight. There was a corresponding change in total drying time, with linen toweling drying in a slightly longer time than the cotton toweling during the first two periods of service, while the reverse was true during the last period of service. Linen toweling had the disadvantage of decreasing more markedly in breaking strength than cotton toweling as a result of laundering and use.

MATERIALS AND METHODS

Because of the great amount of time required for subjecting towels to laundering and use, one cotton and one linen toweling were studied. These were plain weave, bleached, desized fabrics selected on the basis of similarities in their physical properties. Yarn properties of the desized fabrics are given in Table I. A bolt of approximately 50 yards of each toweling was purchased, and each 50-yard piece was cut into three sections of equal length. Eight towels were cut from each section of each of the two fabrics. One pair of towels from each block was allotted to each laundering period, one towel of the pair being laundered but not used while the other was used to dry dishes and laundered. After the towels were desized by an enzyme, one 10-inch shrinkage square was marked on each towel with sewing thread.

TABLE I
Yarn number, twist of yarns, and breaking strength of yarns from desized, plain weave cotton and linen towelings

Fiber composition and direction of test	Yarn number (Grex)[1]	Twists per inch (no.)[2]	Breaking strength (gms)[3]
Cotton:			
Warp	564	14.74	751.6
Filling	741	11.28	801.6
Flax:			
Warp	884	8.00	654.4
Filling	952	7.81	750.9

[1]Means of 9 determinations.
[2]Means of 21 determinations.
[3]Means of 45 determinations.

To produce wear resulting from drying dishes, each towel allotted to this treatment was used for drying a group of a) breakfast dishes, b) luncheon dishes, and c) dinner dishes by a uniform procedure. When the dishes for one meal had been wiped, the towel was hung on a rack at room temperature to dry in a current of air from an electric fan. After a towel was used to dry dishes for three meals, it was laundered.

The towels were laundered in a wash wheel of the type used for determinations of dimensional change (*14*). The laundering procedure is given in Table II. After laundering, the towels were squeezed by hand

TABLE II
Laundering procedure

Procedure	Temperature (°F)	Depth of water (inches)	Weight of Soap (gms)	Time (min)
Wash no. 1	105	6	20	5
Wash no. 2	140	3	5	10
Rinse no. 1, 2, 3	140	8	..	3
Rinse no. 4	120	8	..	3

TABLE III

Fabric count, thickness, weight, and dimensional change of untreated, laundered only, and laundered and used plain weave cotton and linen toweling

Fiber composition and number of launderings	Counts per inch[1]				Thickness (1/1000 inch)[1]		Weight (Oz per sq yd)[1]		Dimensional change (percent)[2]			
	Warp		Filling						Warpwise		Fillingwise	
	Laundered only	Laundered and used	Laundered only	Laundered and used	Laundered only	Laundered and used	Laundered only	Laundered and used	Laundered only	Laundered and used	Laundered only	Laundered and used
Cotton:												
0 launderings	39.1	39.0	32.8	32.8	20.4	20.1	6.29	6.46	....	....	....	....
20 launderings	38.6	38.6	34.2	34.1	22.8	22.6	6.54	6.46	−3.93	−4.40	0.96	0.67
40 launderings	38.0	38.2	34.6	34.5	22.7	22.4	6.54	6.50	−4.27	−4.26	− .13	.73
60 launderings	38.6	38.3	34.8	34.7	22.9	21.7	6.57	6.44	−5.27	−4.72	.07	.47
Flax:												
0 launderings	33.6	33.5	28.3	28.1	17.4	18.2	7.14	7.23	....	....	....	....
20 launderings	33.1	33.0	29.1	28.3	20.7	20.9	6.54	6.30	−1.44	−1.08	− .13	− .21
40 launderings	33.3	33.6	28.4	28.3	20.9	20.0	6.46	5.99	− .61	− .27	− .61	− .21
60 launderings	33.7	33.3	28.7	27.8	21.8	20.0	6.34	5.53	−1.30	− .34	− .07	− .13

[1]Means of 18 determinations.
[2]Means of 9 determinations.

and hung on a rack to dry at room temperature in a current of air from an electric fan. They were then ironed with an electric hand iron at a temperature of 300° to 325° F.

At the end of the various periods of service (20, 40, or 60 cycles), the following fabric properties of the towels were measured: count, thickness, weight, dry breaking strength by the raveled-strip method, shrinkage, absorption, and drying. Properties were measured under standard conditions after the toweling had reached moisture equilibrium in an atmosphere having a relative humidity of 65 percent, plus or minus 2 percent, at 70° F plus or minus 2° F.

Except for absorption and drying, procedures of the American Society for Testing Materials (*14*) were followed. Absorption was measured with the Larose device (*3*), specimens 2 inches square being weighed after being placed in contact with the moist alundum plate for periods of ¼ minute up to a total of 3 minutes and ½ minute thereafter up to a total of 8 minutes. For each interval, the mean grams of water per specimen and per gram of fabric were calculated, each mean being based upon 9 determinations. For the study of drying, specimens 2 inches square were suspended on wire frames, soaked in distilled water for 12 hours, and weighed at intervals of 10 minutes until there was no further decrease in weight for five successive weighings. The mean number of grams of water per specimen was calculated for each interval. The end of the constant-rate period, the end of the decreasing-rate period in hours, and the grams of water per specimen after drying for 10-minutes were studied.

Statistical methods which were used included the mean, standard deviation, *t* test, analysis of variance, and significant differences between means (*15*).

RESULTS

Absorption of Water by Toweling

EFFECTS OF THE NUMBER OF LAUNDERINGS——For cotton toweling, there was a distinct tendency for absorption to increase with an increasing numbering of cycles of laundering or of use with laundering at the ¼-minute absorption period both on the basis of grams of water per specimen and per gram of fabric (Figures 1 and 2). The same tendency was apparent at the ½-minute period on the basis of grams of water per specimen. On the whole, differences in absorbency for different laundering intervals were smaller and fewer from the 1-minute through the 8-minute absorption periods than at the two earlier periods.

When an examination is made of the effects of fabric properties upon absorption after different cycles of laundering, it is seen that an increase in the number of filling yarns per inch in cotton toweling which was used and laundered and possibly of that which was laundered only was associated with lower absorption after 60 than after 20 launderings (Table III). An increase in thickness of cotton toweling after laundering only or laundering and use for 20, 40, and 60 times was coupled with increased water-holding capacity. Dimensional changes, in turn, were related to certain changes in thickness and count.

Both on the basis of grams of water per specimen and per gram of fabric, absorption by linen toweling which was laundered only or laundered and used increased with an increasing number of launderings through the fortieth laundering but, in some cases, decreased between 40 and 60 launderings (Figures 3 and 4). The increase in absorbency was especially marked between unlaundered toweling and that laundered 20 times. In some cases, increases in absorbency of linen toweling accompanied increases in thickness, and, in a few cases, decreased weight was associated with decreased absorbency.

EFFECTS OF LAUNDERING ONLY AND OF USE WITH LAUNDERING——Differences in the absorbency of cotton toweling which was laundered only and laundered and used were relatively small. There was slightly greater absorption per specimen at the ½-minute period by cotton toweling which had been laundered only as compared with that which had been laundered and used (Figure 1). However, at the 1-, 4-, and 8-minute absorption periods, the grams of water absorbed per gram of fabric were slightly greater for cotton toweling which had been laundered and used than for that which was laundered only (Figure 2).

On the basis of the grams of water absorbed per specimen by linen toweling, only the slightly greater absorption at the ¼-minute period by toweling which had been laundered only as compared with that which had been laundered and used was significant (Figure 3). Except at the ½-minute period, absorption in terms of grams of water per gram of fabric was greater for linen toweling which had been laundered and used than for that which had been laundered only (Figure 4). At each absorption period, the number of significant differences increased with an increasing number of launderings, and the magnitude of the differences increased consistently as the absorption period increased. There were no similar consistent tendencies for linen toweling on the basis of grams of water per specimen. Count, thickness, weight, and shrinkage did not appear to be important factors in differences between absorbency of cotton or linen toweling which was

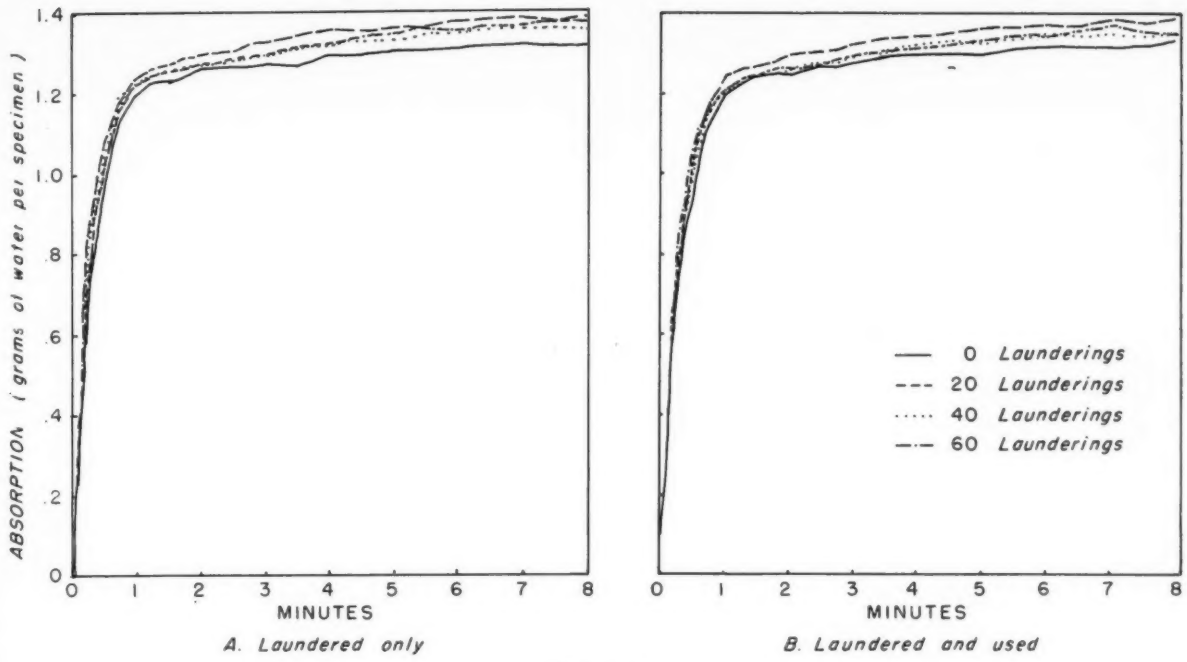

Figure 1
Grams of water absorbed per specimen of constant area by un treated, laundered only, and laundered and used plain weave cotton toweling

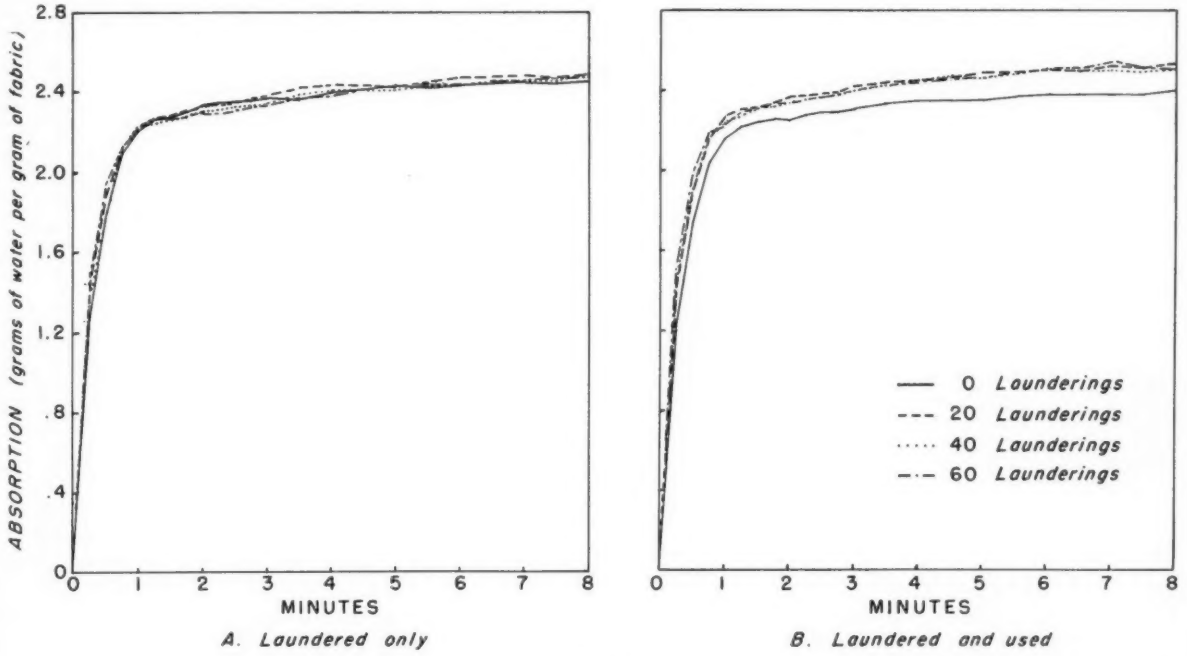

Figure 2
Grams of water absorbed per gram of fabric by untreated, laundered only, and laundered and used plain weave cotton toweling

laundered only and that which was laundered and used.

EFFECTS OF FIBER CONTENT ——The relative absorbency of the cotton and linen towelings varied according to the absorption period, the number of launderings, and whether the toweling was laundered only or laundered and used.

Cotton toweling was more absorbent than linen toweling when unlaundered and generally more absorbent than linen toweling at the early absorption periods of ¼ and ½ minute when laundered only or laundered and used. At the 1-minute period, linen compared somewhat more favorably with cotton than at the earlier absorption periods, and, at the longer absorption periods of 2, 4, and 8 minutes, linen was usually superior to cotton in absorption after 20, 40, or 60 launderings, or laundering with use, especially on the basis of grams of water per specimen. Differences in count may have

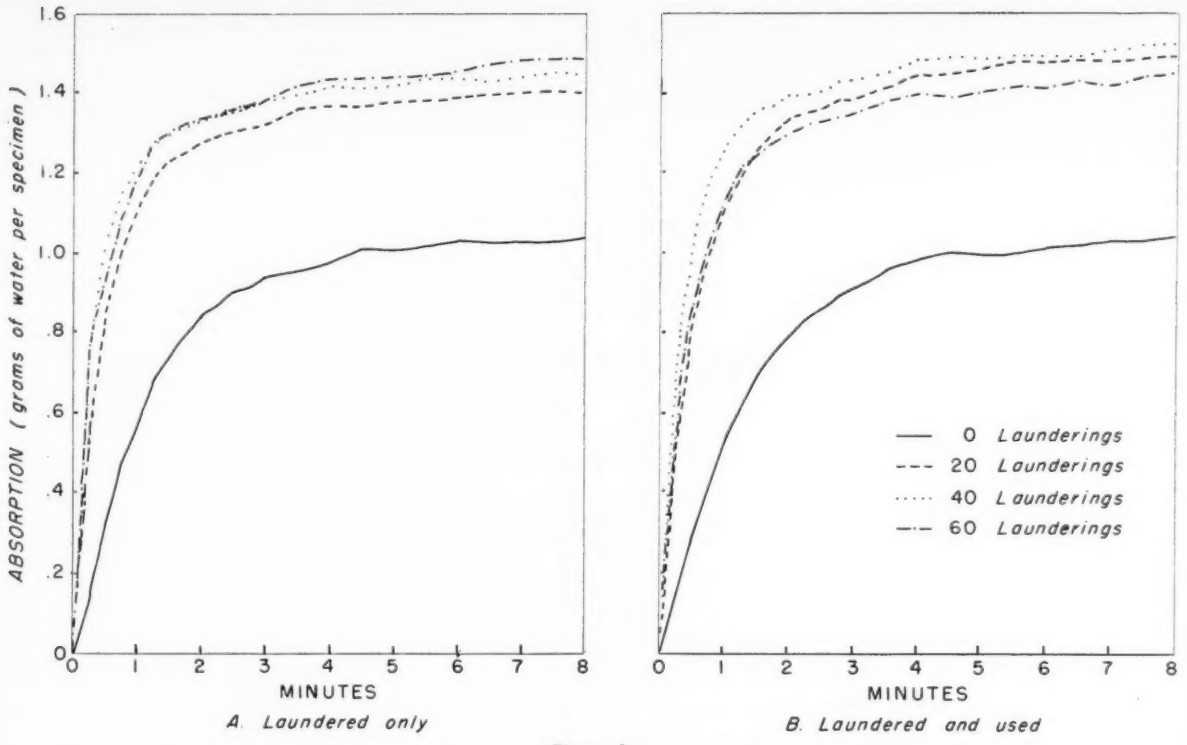

Figure 3
Grams of water absorbed per specimen of constant area by untreated, laundered only, and laundered and used plain weave linen toweling

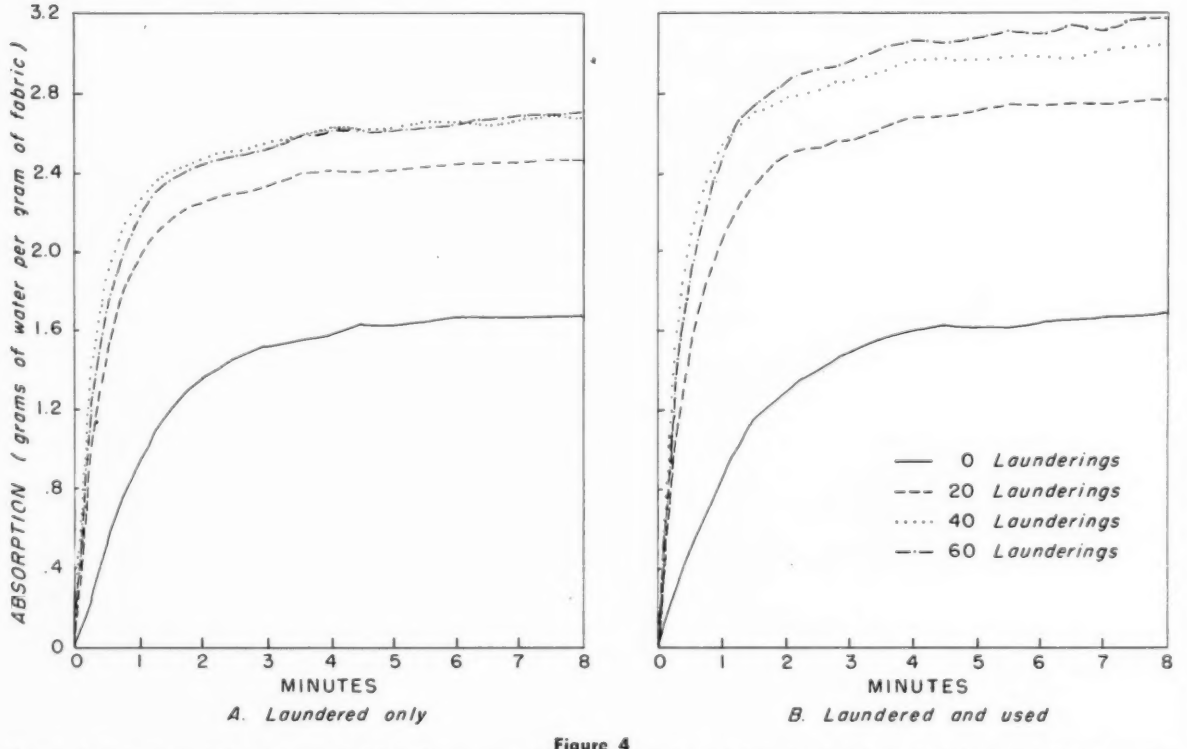

Figure 4
Grams of water absorbed per gram of fabric by untreated, laundered only, and laundered and used plain weave linen toweling

been associated with certain differences in absorbency of cotton and linen towelings.

RELATION OF ABSORPTION OF WATER TO FABRIC BREAKING STRENGTH —— With increasing numbers of cycles of laundering only or laundering and use of cotton toweling, there were some decreases in

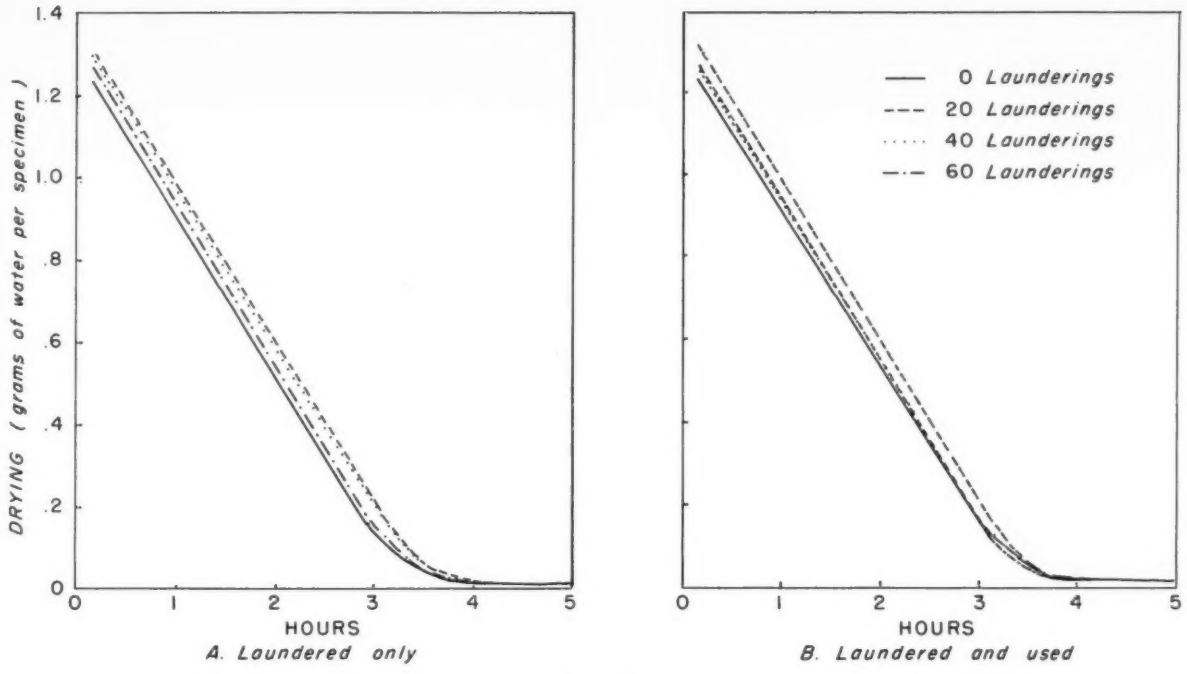

Figure 5
Grams of water per specimen of 4 square inches during drying of untreated, laundered only, and laundered and used plain weave cotton toweling

the warpwise and fillingwise fabric breaking strength of toweling laundered and used 20 times as compared with unlaundered toweling (Table IV). These changes accompanied increases in the absorption of water at the ¼-minute and ½-minute absorption periods. Linen toweling decreased markedly in warpwise and fillingwise breaking strength by the twentieth laundering and decreased significantly in warpwise breaking strength between 20 and 60 cycles of laundering and use. These changes in breaking strength accompanied increases in the absorption of water except for some decreases in absorbency after 40 launderings. Of the fabrics studied, the cotton toweling usually had greater fabric breaking strength than the linen toweling at all laundering intervals both when laundered only and when laundered and used.

Drying of Toweling

All of the cotton and linen toweling subjected to laundering and to laundering and use for different periods dried at approximately the same constant rate until the decreasing-rate period began.

EFFECTS OF THE NUMBER OF LAUNDERINGS——On the basis of the number of launderings, a few significant differences occurred in the grams of water per cotton specimen after drying for 10 minutes, but there were no significant differences in the length of the period of constant rate of drying or the total period of drying (Figure 5 and Table V). After drying for 10 minutes, cotton toweling which had been laundered only contained a greater weight of water if it had been laundered 20 or 40 times than when unlaundered and probably less water if

TABLE IV

Dry fabric breaking strength (pounds) by the raveled-strip method of untreated, laundered only, and laundered and used plain weave cotton and linen toweling[1]

Fiber composition and number of launderings	Warpwise		Fillingwise	
	Laundered only	Laundered and used	Laundered only	Laundered and used
Cotton:				
0 launderings	66.22	65.57	58.76	60.00
20 launderings	60.59	58.13	58.06	54.22
40 launderings	58.28	56.04	58.48	54.08
60 launderings	57.20	54.09	55.00	52.11
Flax:				
0 launderings	62.69	62.48	64.15	58.46
20 launderings	49.54	44.77	52.37	46.85
40 launderings	50.11	42.63	51.48	43.26
60 launderings	44.94	37.63	50.89	38.61

[1]Means of 27 determinations.

TABLE V

Means for grams of water per specimen after drying 10 minutes and ends of periods of constant rate of drying and of decreasing rate of drying for unlaundered, laundered only, and laundered and used plain weave cotton and linen toweling[1]

Fiber composition and number of launderings	Grams of water per specimen after drying 10 minutes		End of constant-rate period (hrs)		End of decreasing-rate period (hrs)	
	Laundered only	Laundered and used	Laundered only	Laundered and used	Laundered only	Laundered and used
Cotton:						
0 launderings	1.238	1.229	2.98	3.13	3.80	4.00
20 launderings	1.305	1.314	3.30	3.35	4.13	4.15
40 launderings	1.292	1.258	3.19	3.20	3.98	3.91
60 launderings	1.269	1.262	3.13	3.15	3.93	4.04
Flax:						
0 launderings	990	1.005	2.35	2.39	3.43	3.44
20 launderings	1.285	1.335	3.15	3.39	4.13	4.37
40 launderings	1.201	1.269	2.95	3.26	3.94	3.95
60 launderings	1.298	1.252	3.30	3.09	4.20	4.00

[1]Means of 9 determinations.

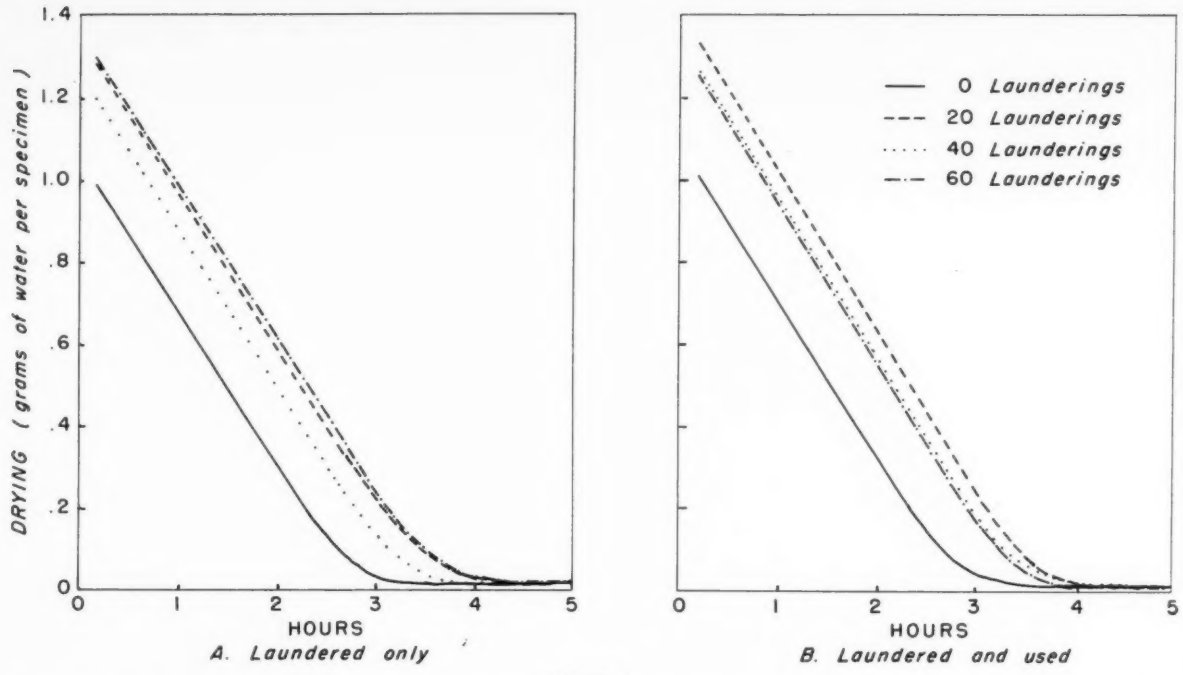

Figure 6
Grcms of water per specimen of 4 square inches during drying of untreated, laundered only, and laundered and used plain weave linen toweling

laundered 60 times than if laundered 20 times. After drying for 10 minutes, cotton toweling which had been laundered and used 20 times contained a greater weight of water than that which was unlaundered, but, after 40 or 60 cycles, it contained slightly less water than after 20 cycles of use and laundering.

In linen toweling, the major differences which depended upon the number of laundering cycles were the increases in the grams of water per specimen after drying for 10 minutes, the longer period of constant-rate drying, and the longer total drying period after 20, 40, or 60 cycles of laundering or laundering and use as compared with unlaundered toweling (Figure 6). Linen toweling which was laundered and used 20 times probably contained slightly more water per specimen after drying for 10 minutes. and it had a longer period of constant-rate drying and longer total drying time than toweling laundered and used 60 times.

EFFECTS OF LAUNDERING ONLY AND OF LAUNDERING AND USE———When the drying of toweling was compared on the basis of treatments, it was found that the grams of water per specimen after drying for 10 minutes and the ends of the periods of constant rate of drying and decreasing rate of drying were not significantly different for cotton or linen toweling which was laundered only as compared with that which was laundered and used.

EFFECTS OF FIBER CONTENT ———The major difference in the drying of cotton and linen toweling was apparent in the unlaundered fabric, the unlaundered cotton toweling holding markedly more water per specimen after drying for 10 minutes and having a longer period of constant rate of drying and a longer total drying period than unlaundered linen toweling.

As laundering increased the amount of water taken up by linen toweling to a greater extent than the amount taken up by cotton toweling, differences in the drying of fabrics made from the two fibers were smaller after 20, 40, or 60 launderings than when unlaundered. Among toweling which was laundered only 20 or 40 times, cotton toweling contained more water after drying 10 minutes, had a longer period of constant rate of drying, and, at 40 launderings, had a greater total period of drying than did linen toweling. However, the reverse was true of toweling laundered only 60 times. After being laundered and used 20 or 40 times, the length of the constant-rate period of drying and of the total drying period were slightly longer for linen than for cotton toweling, but the reverse was true after being laundered and used 60 times.

In this section of the study, the close relationship between the number of grams of water held after drying for 10 minutes and the length of the constant-rate period, as well as the length of the total drying period, was apparent.

SUMMARY AND SIGNIFICANCE OF FINDINGS

After repeated launderings, cotton toweling decreased relatively little in breaking strength and generally took up moisture more readily than linen toweling during the early part of the absorption period, which would be of especial importance in the drying of dishes. However, when the toweling absorbed water to a point approaching saturation, a common household practice, linen toweling generally took up more moisture than cotton toweling. The linen toweling also had the advantage of increasing in absorbency with increasing laundering up to a certain point, after which it decreased in absorbency as the fabric decreased in weight. There was a corresponding change in total drying time, with linen toweling drying in a slightly longer time than the cotton toweling during the first two periods of serv-

(Concluded on page 576)

DISPERSED GROWTH AERATION OF COTTON FINISHING WASTES
II. EFFECT OF HIGH pH AND LOWERED AIR RATE

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INTRODUCTION

THE author recently presented a paper concerning the holding and aeration of cotton finishing wastes (*1*). These treatments were highly effective but somewhat costly. The objective of this investigation was to determine the effect of aerating highly alkaline waste on the treatment efficiency.

PROCEDURE

Pilot plant studies (*1*) were carried out at the Lyman Printing and Finishing Co (formerly a part of Pacific Mills) over a four-month period. The air rate was gradually reduced and the CO_2 (neutralizing agent) was eliminated entirely. Samples were collected each half-hour and composited over a four-hour period. Temperature, pH, total plate counts and biochemical oxygen demand (BOD) were determined. All analyses were carried out in accordance with Standard Methods of analyses for water, sewage and wastes. The waste flow through the pilot plant was constant at 2 gpm during the entire study. The results are presented in Table I.

DISCUSSION

EXCESS AIR AND A NEUTRAL WASTE———Aeration for 12 hours after holding a neutralized waste yielded a BOD reduction of 71%. It was calculated that the daily cost of supplying the air for oxidation and CO_2 for neutralization was 112 and 28.50 dollars, respectively, per millon gallons of waste. This cost may be permissible for a mill discharging only a fraction of a million gallons per day, but would not normally be acceptable to a large mill producing over a million gallons of waste per day.

Too little attention has been given in the past to biological treatment of highly alkaline and organic wastes without neutralization and at lowered air rates. These pilot-plant studies show that, by eliminating the neutralization, the BOD reduction is 38.8% at an air cost of $112 per million gallons per day. True, the BOD reduction is not too high, but it is often all that is required to protect a given watercourse. The cost, however, can still be reduced.

A reduction in air rate of 50% resulted in a 46.4% BOD reduction. It was therefore apparent that the initial air rate was excessive. The cost of supplying this air would be only $74.80 per million gallons.

When the air rate was lowered still further to 25 cfm, the BOD reduction was still 33.6%. The cost would be reduced to only $46.70 per day per million gallons.

The process is at least in part biological, as evidenced by the total number of bacteria present in the aeration basin. The numbers varied considerably; often receded to almost zero; but recovered systematically. Extremely high pH values (11.6) usually caused lower bacterial numbers and an abundance of dissolved oxygen in the aeration basin. As the pH lowered slightly, the reverse was evident.

There appeared to be little or no correlation between the operating temperature and the efficiency of the process.

It should be noted that, unfortunately, the operation of the pilot plant was discontinued because of other duties for the personnel. It is the writer's opinion that the system would function at an even lower air rate than 1520 ft ^{3}/#BOD. Thus, a lower cost would be effected.

It is interesting to compare sewage activated sludge aeration costs with these described above. The aeration of 1 mgd of normal, domestic sewage (which is a rapidly disappearing commodity today) would cost about $3.00 (at an air rate of 800 ft ^{3}/#-BOD added). This is only 6-7% of the cost of the aeration of the cotton mill waste described above. However, the sewage is only 10-12% as pollutional (as far as BOD load is concerned). Therefore, if the two were compared on a pollutional load basis the costs would be quite similar. There are at least two advantages of this type of treatment over the activated sludge process:

1) high, sensitive sludge concentrations do not have to be maintained, circulated (and aerated), recirculated, reaerated, and finally

TABLE I
Effect of Neutralization and Dispersed Growth Aeration on Cost and Efficiency of Cotton Mill Finishing Waste Treatment

Air rate (cfm)	Ft³/#BOD	No. of 4-hour composits analyzed	Raw waste 20°C, 5-day BOD pH	Raw waste 20°C, 5-day BOD (ppm)	Holding basin effluent (10 hrs) pH	Holding basin effluent (10 hrs) BOD (ppm)	Holding basin effluent (10 hrs) (% Red)	Aeration basin effluent (12 hrs) pH	Aeration basin effluent (12 hrs) BOD (ppm)	Aeration basin effluent (12 hrs) (% Red)	Mean temp (°F)	Mean total bacterial numbers/ML	Cost ($/day) Air[a] mg	Cost ($/day) CO_2[b] mg
60	3600	18	11.3	798	7-8	711	10.9	7-8	232	71.0	—	—	112	28.50
60	4650	48	11.3	765	11.0	702	8.3	10.0	468	38.8	64	5,350,000	112	0
50	3440	45	11.3	873	10.9	775	11.2	8.4	500	42.7	68	25,300,000	93.50	0
40	2210	9	11.3	1084	9.6	1102	0	8.3	580	46.4	66	61,000,000	74.89	0
30	1890	36	11.3	951	11.2	880	7.5	8.5	540	43.2	75	32,200,000[c]	56.10	0
25	1520	62	11.3	984	11.0	891	9.5	8.2	654	33.6	86	88,700,000[d]	46.70	0

[a] Based on a rate of 500 HP/cfm air at 6 psi and $.01/KWH
[b] Based on rate of $.005/hrs #$CO_2$
[c] Varies 400-9 mil
[d] Varies 0-180 mil

disposed of; and

2) the operator need not be as skilled or as attentive to the process.

It is true that the process described only yielded about one-half the BOD reduction normally expected of the activated sludge sewage process. On the other hand, sewage is normally neutral in pH whereas this process is handling a waste as alkaline as lye.

ACKNOWLEDGEMENT

The writer is sincerely grateful to the Lyman Printing and Finishing Co for sponsoring these studies. The pilot plant analyses were under the direct, capable supervision of Marshall Bright.

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Cotton and Linen Toweling———

(Concluded from page 574)

ice, while the reverse was true during the last period of service. Linen toweling had the disadvantage of decreasing more markedly in breaking strength than cotton toweling as a result of laundering and use. However, two other factors which would favor linen, absence of linting and a more agreeable "feel" to the hand, were not a part of this study.

ACKNOWLEDGMENT

The writer wishes to express her appreciation to Prof Ethel L Phelps for her help in directing this study and to Dr Horace L Thomas for his advice on statistical methods. The work was made possible partly through the financial assistance of the Effie I Raitt Fellowship of the American Home Economics Association.

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Abstracts

Peroxide Bleaching of Minor Vegetable Fibers

Anon, *Tech Bull (du Pont)* **12**, 138-44, Sept, 1956

There are many minor vegetable fibers, such as hemp, jute, sisal and straw, that are used in commercial quantities. There are wide variations in the coloring matters, luster, strength, etc, of these natural fibers, some of which are weakened or even destroyed if any attempt is made to bleach them.

The author discusses general procedures for bleaching a few of these fibers with Albone (hydrogen peroxide) and Solozone (sodium peroxide). These products can be handled in equipment made of stainless steel, wood, glassware, earthenware or enamelware.

Jute is the cheapest of the textile fibers. Its color varies from brown to yellowish white or silver gray. In bleaching jute, or burlap, best results are generally obtained when repeated peroxide treatments are given with no preliminary alkaline boil or scour. Because of the acidic nature of the impurities in this fiber, it is advisable to use sufficient amounts of silicate to provide a well-buffered bath. The bleaching action proceeds more rapidly and uniformly if the fiber is washed thoroughly with a synthetic detergent prior to bleaching. A temperature of 180°F is recommended for the bleach bath.

Ramie is the strongest of the bast fibers. It is very durable and resists rot when exposed to weather and when immersed in water. Most ramie fibers are extremely white, but some varieties are a light straw color. This can be bleached by pretreating with caustic soda and then bleaching with Albone and silicate at 180° F.

Hemp is the name applied to a variety of bast fibers. Some grades are white, but ordinary hemp is dark brown in color and too harsh and stiff for use in woven fabrics. It is not often used in the textile trade, but some hemp is bleached in the form of braids and hat bodies. The bleaching treatment is the same as for leaf fibers (see Panama).

Sisal is a coarse leaf fiber obtained from the agave plant. The color ranges from near-white to yellowish brown. The fiber is readily bleached with peroxide and silicate at 180°F. It is seldom used in the textile field, but is one of the principal fibers used for twines, ropes and cords.

Panama is a fiber from the leaves of the jipijapa, used for making hat bodies. These are first scoured with soap and a wetting agent, and are then bleached by being submerged for several days in an Albone bath of special composition. The pH of the bath must not be allowed to drop below 6.4.

The author gives full instructions for carrying out these various bleaching operations, but does not guarantee the results.—WHC

Dyeing and Drying of Tufted Carpets

Anon, *Man-Made Textiles* **34**, No. 397, 70, June, 1957

The tufted carpet industry has been founded on plain colored carpets, a large proportion of them dyed in the piece. New techniques now under active development include pressure dyeing, continuous dyeing on the pad-steam principle, and the use of newer dyestuffs like the Procions (ICI) which simplify the conditions of processing.

For the present, however, winch dyeing techniques are the dominant feature of the trade. With selected direct dyes and appropriate methods, winch dyeing on viscose pile carpeting gives level results of satisfactory fastness. In devising suitable methods the problems encountered have been largely due to the great width and weight of carpet to be handled in one dyeing operation.

The preferred form of winch becks in the specially designed machines, up to 20 feet in width, seems to be deep rather than shallow, although the back of the beck is suitably sloped to act like a scray in guiding the heavy full-width carpeting into even folds.

One difficulty has been to secure even application of the dye liquor to the fabric. With the usual arrangements provided in a winch machine there is a marked tendency for the

(Concluded on page 608)

Proceedings of the
American Association of Textile Chemists and Colorists

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August 12, 1957

PROPOSED AMENDMENTS TO THE CONSTITUTION

THE Committee on Constitution and Bylaws in cooperation with the officers of the Association, early this year, undertook a study and review of the AATCC Constitution. Changing conditions indicated that some revision might be desirable, and at the same time it appeared that some portions of the Constitution on which there had been some doubt required clarification.

Prior to the 206th meeting of the Council on March 29, 1957, the chairman of the Committee on Constitution and Bylaws, acting as the original proponent presented to the Executive Secretary a proposal to amend the Constitution supported by the signatures of 131 Senior members. The proposal was presented to the 206th Council meeting for discussion and was then referred back to the Committee on Constitution and Bylaws. Minor changes in the proposal were made by the Committee, approved by the original proponent and submitted at the next following meeting of the Council on June 7, 1957. By majority vote, on June 7, 1957, the Council approved the proposed amendments.

To further carry out the requirements for amending the Constitution as set forth in Article VIII, the proposals are herewith presented to the membership in the *Proceedings* of the Association. Accompanied by printed copy of this record of vote and statement, the proposals will be submitted to a vote of the entire Senior membership of the Association on ballots mailed with the next ballots issued for the election of officers of the Association.

Article IV, Section 1

Delete the asterisk and the corresponding foot note and add the following sentence to this Section:

"In determining fulfillment of experience requirements, graduation from a textile school of college grade, or a bachelor's degree in chemistry or other physical science will be counted the equivalent of two years practical experience, and a more advanced degree the equivalent of another year. Service for one year or more in the Armed Services of the United States will be accepted as a year of experience. However, the total of all such credits in lieu of practical experience shall not exceed three years."

Article V, Section 2

Substitute "an Executive Secretary" for "a Secretary", "an Executive Committee on Research" for "a Research Committee", and "National Councilors" for "Sectional Councilors" so that the Section shall read as follows:

"The Council of the Association shall consist of a President, four Vice Presidents, an Executive Secretary, a Treasurer, the Chairman of an Executive Committee on Research, the Past Presidents, the National Councilors representing and elected by their Sections . . . "

Article V, Section 4

Substitute in the second sentence "National" for "Sectional" so that this sentence shall end as follows:

"—— —or as a National Councilor."

Article V, Section 5

Insert "Executive" before "Secretary"; substitute "Executive Committee on Research" for "Research Committee" so that this Section will read as follows:

"The Executive Secretary, the Treasurer, and the Chairman of the Executive Committee on Research shall be appointed by the Council, and no individual may hold two of these offices concurrently."

Article VI, Section 1

Insert "National" before "Councilors," in the first sentence to read:

"—— consisting of the National Councilors representing Sections."

In the second sentence, insert "Executive" before "Secretary of the Association" so that this will read—"The Executive Secretary of the Association shall serve as Secretary of this Committee . . . "

Article VI, Section 2

Insert "Executive" before "Secretary" to read as follows: " . . . with the Executive Secretary not later than October first."

Article VI, Section 3

In the first paragraph, first sentence, insert "Executive" before "Secretary." In the first paragraph, second sentence, insert "properly" before "marked," substitute "received by the Executive Secretary" for "returned"; insert "his" before "mailing" and "date" after "mailing"; substitute "the seventh" for "one," insert "Executive" before "Secretary," so that the first paragraph, second sentence will read as follows:

"Ballots properly marked and received by the Executive Secretary within six weeks of his mailing date, shall be counted within the seventh week after said mailing date by the Executive Secretary and two tellers appointed by the President."

In second paragraph, first sentence, insert "Executive" before "Secretary"; substitute "National Councilors" for "members of the Council," so that the latter part of this sentence shall read as follows:

"—— —shall be mailed by the Executive Secretary, within three days, to all the National Councilors representing Sections."

In the second paragraph, second sentence, substitute "received by" for "returned to"; insert "Executive" before "Secretary"; insert "his" before "mailing" and "date" after "mailing," so that this sentence shall read as follows:

"On ballots received by the Executive Secretary within three weeks of his mailing date, the largest number . . . "

In second paragraph, third sentence, substitute "National Councilors representing that Region" for "Council representatives from that Region," to read as follows:

" . . . shall be confined to the Na-

(*Concluded on page P601*)

Northern New England Section &
Lowell Technological Institute Student Chapter———

EFFECT OF CERTAIN ACID DYE STRUCTURES ON THE RATE OF WOOL DYEING*

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In recent years, investigations of the effects produced by certain variables on the rate of dyeing have been studied at the Lowell Technological Institute in the hope that the accumulated knowledge will eventually lead to a better understanding of the exact mechanism by which wool dyeing takes place.

In this investigation three variables have been studied: 1) the effect of the basic dye structure, 2) the effect of the size of the dye molecule, and 3) the effect of the position of the sulfonic acid group or the shape of the dye molecule. The effects produced by these variables are discusssed in detail on the basis of two determined properties of the dyeing system: the "F" value (logarithm of the distribution ratio), which is used as a measure of the affinity of the dye for the wool fiber, and the L g t (sec) ½ value, which is used as a measure of the rate of dyeing.

INTRODUCTION

THE dyeing of wool with acid dyes is a process complicated by the effects of many variables. In the past, many workers have carefully studied the effect of such variables as temperature, agitation, form of the substratum, pH, and dyebath composition essentially on the equilibrium conditions of the dyeing. However, in recent years investigations of the effects produced by certain variables on the kinetics of dyeing have been studied at the Lowell Technological Institute in the hope that the accumulated knowledge will eventually lead to a better understanding of the exact mechanism by which wool dyeing takes place.

Since dyeing is not an instantaneous process, it is essential to consider not only the final equilibrium state of a dyeing system, but also the kinetic behavior of the dye in that system. Rate studies, in the past, have been made under conditions nearly similar to those used in practice. However, this introduces so many variables that it is difficult to attribute the effect produced to the variable being studied. On the other hand, dyeing under idealized conditions would lend itself to a more precise study of the various effects produced by these variables in the dyeing process by simplifying the number of simultaneous actions occurring in the system.

This investigation is a continuation of the work done by Sakaguchi *(1)* and Chiklis *(2)*, who studied the effect of the degree of ionization of wool in the dyeing of monovalent and divalent acid dyes. These workers have shown that the dyeing process of wool with acid dyes can be simplified by a pretreatment of the wool fibers with acid at a known degree of saturation. The actual dyeing then follows this acid treatment. The complication of acid and dye diffusion into the fiber occurring simultaneously is eliminated, and only dye diffusion into the fiber occurs during the dyeing process. This allows for a more exact study of the behavior of the dye itself during the dyeing process.

In this investigation the method of dyeing developed by Sakaguchi *(1)* and Chiklis *(2)* was adopted in order to determine the effect of certain dye structures on the rate of wool dyeing. Five monovalent acid dyes were selected and arranged in four pairs so that each pair was similar in all respects except for the variable being studied. The variables studied were 1) the effect of the basic dye structure, 2) the effect of the size of the dye molecule, and 3) the effect of the position of the sulfonic acid group or the shape of the dye molecule.

EXPERIMENTAL

All dyes used in this investigation were purified according to the method decribed by Levy *(3)*, which is a method originally suggested by Lubs *(4)* and modified by Gaidis *(5)*. The method consisted of repeated salting out with sodium acetate, the excess sodium acetate being extracted with portions of boiling 95% ethanol. The *Colour Index* numbers and the structural formulas of the dyes are given in Figures 2, 4, 6, and 8.*

The wool fibers used were the remainder of the scoured wool utilized by Sakaguchi *(1)* and Chiklis *(2)*, so that the results obtained in this investigation may be comparative to theirs. The scouring procedure, as described by Sakaguchi *(1)*, essentially consisted of scouring the wool top with a nonionic detergent and a sequestering agent. Previous work has shown that this method is as effective as solvent extraction.

The dyeing procedure consisted of a pretreatment of the chopped wool fibers at 60° C under reflux and constant agitation with a predetermined *(1)* concentration of hydrochloric acid so as to obtain a saturation value of 1.00 equivalents per kilogram of wool fiber. After the fibers had reached equilibrium with the acid, the dye was added to the bath. At given time intervals, samples of the dyebath were withdrawn and their transmission measured on a Coleman Junior Spectrophometer. The dyebath exhaustion at each time interval was determined from previously prepared calibration curves. When three fairly large consecutive time intervals showed no change in exhaustion, the dyeing was considered to have reached equilibrium.

From the results obtained, the following parameters of the dyeing system were determined:

1) *Equilibrium Exhaustion*, E_∞

This value is considered as the amount of dye removed from the dyebath as a percentage of the original amount of the dye present in the dyebath. Equilibrium exhaustion expresses the maximum amount of dye which can be removed from the dye solution under the particular dyeing conditions being used.

2) *Time of Half Dyeing*, $T_{\frac{1}{2}}$

The time of half dyeing is the time required for the material being dyed to exhaust one-half as much dye as

*Presented by Edward W Makuch before a joint meeting of the Northern New England Section and Lowell Technological Institute Student Chapter held at Lowell, Mass, on May 10, 1957.

*The *Colour Index* numbers shown in Figures 2, 4, 6, and 8 and mentioned elsewhere in the text are from the old *Index*. Equivalent numbers in the new *Colour Index* are shown in the Appendix at the end of this article.

it will exhaust at equilibrium. In this investigation, the time of half dyeing represented by $T_{1/2}$ is expressed in minutes and by $t_{1/2}$ in seconds. This value has been shown by Sakaguchi *(1)* to be the best parameter as a measure of the dyeing rate, and has a sound theoretical basis for its use. The Log $t_{1/2}$ values *(6)* are used as a measure of the rate of dyeing.

3) *Logarithm of the Distribution Ratio*, F=Log $(D)_f/(D)_s$ or F=Log (BR $E\infty/1-E\infty$)

The distribution ratio, $(D)_f/(D)_s$, is a measure of the molar distribution of the dye in the fiber to the dye in solution at equilibrium. The bath ratio (BR) is a measure of the volume of the dyebath to the weight of wool fiber used. The "F" values *(6)* are used as a measure of the affinity of the dye for the wool fiber.

DISCUSSION OF RESULTS

1) THE EFFECT OF THE BASIC DYE STRUCTURE———Two dyes, *Colour Index* numbers 148 and 1034, were used; these dyes are as nearly identical in size as well as in type and number of constituent groups as was possible to obtain except that number 148 has an azo linkage and number 1034 has an anthraquinone linkage (see Figure 2). Figure 1 shows a plot of fractional exhaustion against the square root of time, the data of which are given in Table I. Observation of this plot indicates that varying the basic structure of the dye does not cause a significant difference in their dyeing behavior for practically the first half of the dyeing. Beyond this point, the curves deviate considerably in the rate at which equilibrium exhaustion is reached.

Figure 2 compares the structural formulas of the dyes used in this investigation and their respective equilibrium exhaustion and time of half dyeing. It can be seen that the dyes are nearly identical except for the mode of linkage. In comparing the times of half dyeing ($T_{1/2}$), it is evident that the two values are not appreciably different indicating that the overall rates of dyeing are practically similar. On the other hand, a comparison of the equilibrium exhaustions shows that these values are significantly different, the anthraquinone dye being 6.0% higher under these dyeing conditions. This indicates that the basic structure of the acid dye influences the final equilibrium exhaustion, but does not appreciably affect the overall rate of dyeing. The "F" values and Log $t_{1/2}$ for these two dyes are as follows:

Colour Index Number	F	Log $t_{1/2}$
148 (azo)	2.89	1.48
1034 (anthraquinone)	3.24	1.54
Difference:	0.35	0.06
% Difference:	11%	4%

It can be seen from the above comparison of the "F" values that the basic dye structure appreciably affects the affinity of the dye for the wool fiber, the anthraquinone dye being 11% greater. On the other hand, a comparison of the Log $t_{1/2}$ values shows that the basic dye structure does not greatly affect the overall rate of dyeing. It will be shown later that this effect may be due to the fact that the anthraquinone linkage forms an additional carbon ring.

2) THE EFFECT OF THE SIZE OF THE DYE MOLECULE———Two dyes, *Colour Index* numbers 151 and 176, were used to determine the effect of increasing the size of the hydrophilic end of the dye molecule. These dyes are identical in all respects except that number 176 differs from 151 only in the replacement of a benzene by a napthalene nucleus on the hydrophilic end of the dye molecule (see Figure 4). The data for these dyes are given in Table I, and illustrated by Figure 3. It can be seen from this plot that the two curves differ appreciably in the magnitude of their slopes suggesting that the rate of diffusion of the larger dye molecule is slower as would normally be expected.

Figure 4 compares the structural formulas of these two dyes and their respective equilibrium exhaustion and time of half dyeing. A comparison of the $T_{1/2}$ values shows that the larger dye molecule is practically twice the value of the smaller dye molecule indicating that the larger the size of the dye molecule the slower will be its rate of dyeing. A comparison of the equilibrim exhaustions of these two dyes shows that an increase in the size of the dye molecule by an additional benzene ring on the hydrophilic end increases the equilibrim exhaustion by only a small amount, the larger dye molecule being 1.0% greater. The data tends to suggest that both the rate of dyeing and the equilibrium exhaustion are affected by the size of the dye molecule. The "F" values and the Log $T_{1/2}$ for these dyes are as follows:

Colour Index Number	F	Log $t_{1/2}$
151 (S-B-A-N)	3.79	1.58
176 (S-N-A-N)	4.22	1.89
Difference:	0.42	0.31
% Difference:	10%	16%

It is evident from the above comparison of the "F" values that the affinity of the larger dye molecule (#176) is greater than the affinity of the smaller dye molecule (#51), the larger dye molecule being 10% greater. It is also noted that increasing the size of the dye molecule by an additional benzene ring increases the affinity practically the same amount as changing the basic dye structure previously discussed. This suggests that the increase in affinity of the anthraquinone dye (#1034) may be due to the formation of a carbon ring. A comparison of the Log $t_{1/2}$ values shows that an increase in the size of the dye molecule on the hydrophilic end decreases the overall rate of dyeing by 16%. It is evident from this analysis that the size of the dye molecule affects both the affinity of the dye for the wool fiber and the overall rate of dyeing.

A comparison can also be made between the dyes of *Colour Index* numbers 176 and 26. This illustrates the effect of increasing the size of the hydrophobic end of the dye molecule on the rate of dyeing and equilibrium exhaustion. The data for the dyeing process of these two dyes are given in Table I. Figure 5 shows a plot of fractional exhaustion against the square root of time illustrating the dyeing behavior of these dyes. It is

TABLE I
Dyeing Process

Time (mins)	$\sqrt{T}$	Fractional Exhaustion, E/E$_\infty$ B-B(azo)	B-B(anth)	S-B-A-N	S-N-A-N	S-N-A-B
0.25	0.5	0.332	0.295	0.304	0.202	0.222
1	1.0	0.659	0.678	0.607	0.441	0.512
2.25	1.5	0.758	0.917	0.914	0.707	0.835
4	2.0	0.856	0.970	0.980	0.964	0.948
6.25	2.5	0.912	0.983	0.989	0.996	0.987
9	3.0	0.937	0.991	0.992	0.998	0.989
12.25	3.5	0.954	0.994	0.995	0.999	0.993
16	4.0	0.970	0.997	0.996	1.000	0.994
20.25	4.5	0.981	0.999	0.997	1.000	0.997
25	5.0	0.986	1.000	0.998	1.000	1.000
36	6.0	0.992	1.000	1.000	.....	1.000
49	7.0	0.994	1.000	1.000	.....	1.000
64	8.0	0.999	.....	1.000	.....	.....
81	9.0	1.000	.....	.....	.....	.....

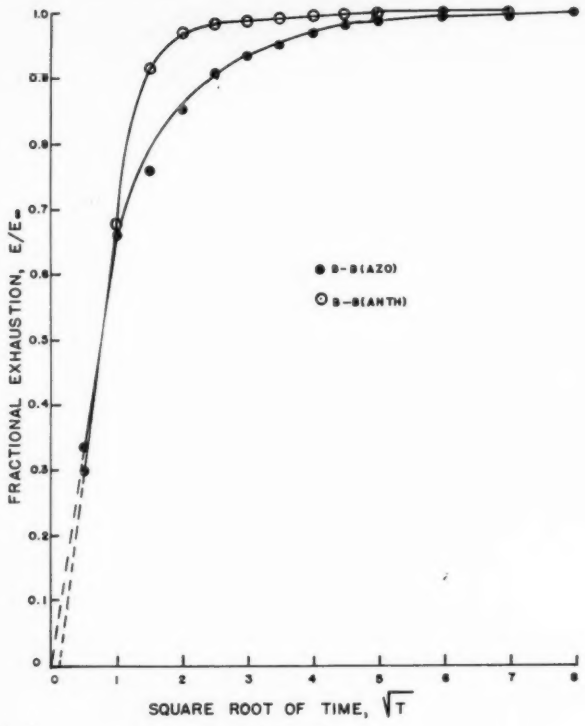

Figure 1
Fractional exhaustion vs sq root of time

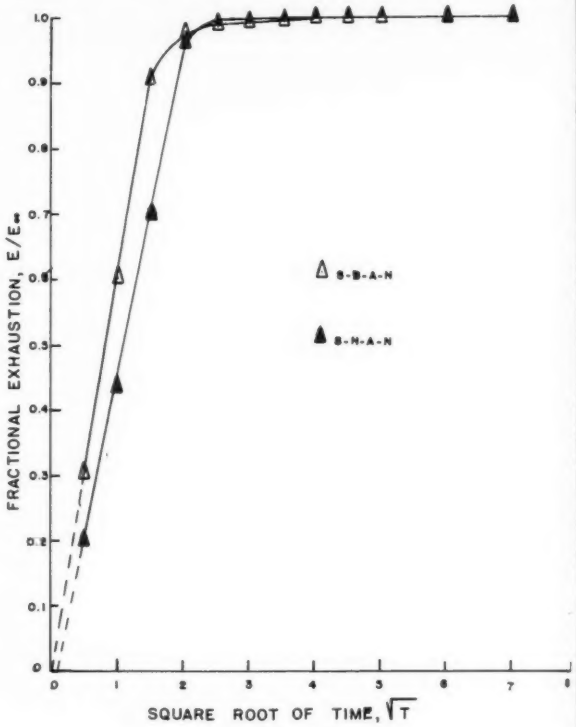

Figure 3
Fractional exhaustion vs sq root of time

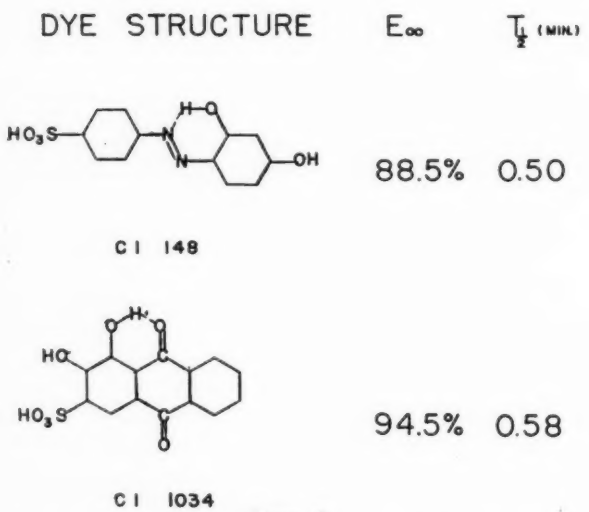

Figure 2
Effect of basic dye structure on the rate of dyeing and equilibrium exhaustion

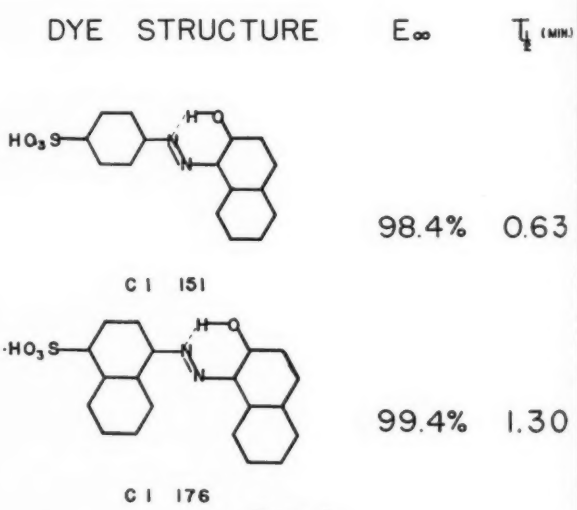

Figure 4
Effect of increasing the nuclear component of the azo dye structure on the rate of dyeing and equilibrium exhaustion

evident from this plot that the two curves differ somewhat under these dyeing conditions. It can also be seen that the magnitude of their slopes do not differ as greatly as in the case of increasing the size of the hydrophilic end of the dye molecule mentioned above.

Figure 6 shows a comparison of the structural formulas, equilibrium exhaustion, and time of half dyeing of these two dyes. It can be seen that number 176 is similar in structure to number 26 except for the additional benzene ring on the hydrophobic end of the dye molecule. A comparison of the $T_{1/2}$ values and equilibrium exhaustions shows that increasing the size of the hydrophobic end decreases the overall rate of dyeing, and slightly increases the equilibrium exhaustion. The "F" values and the Log $t_{1/2}$ for these two dyes are as follows:

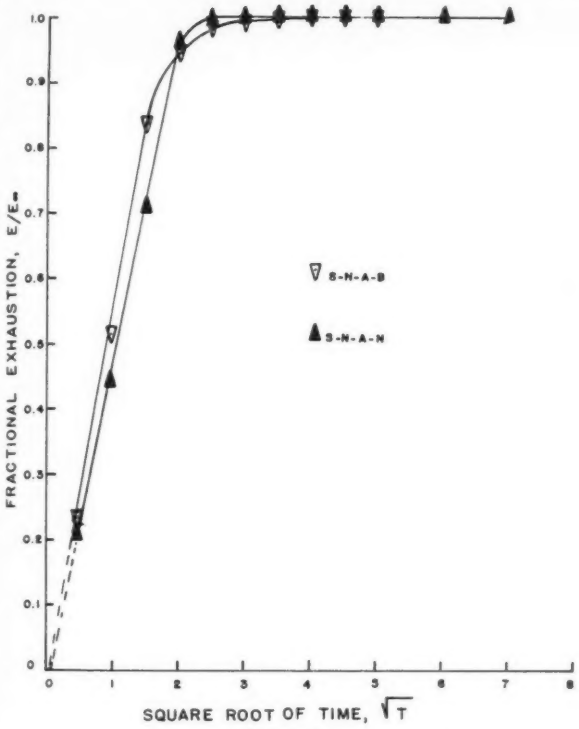

Figure 5
Fractional exhaustion vs sq root of time

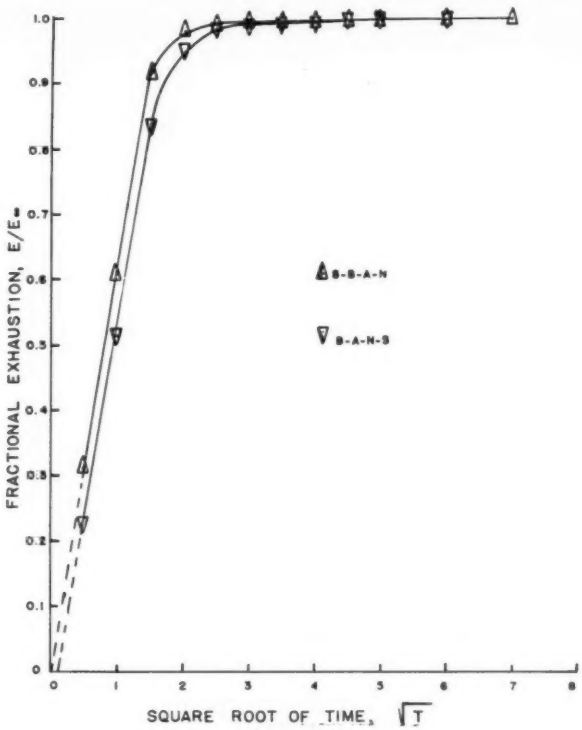

Figure 7
Fractional exhaustion vs sq root of time

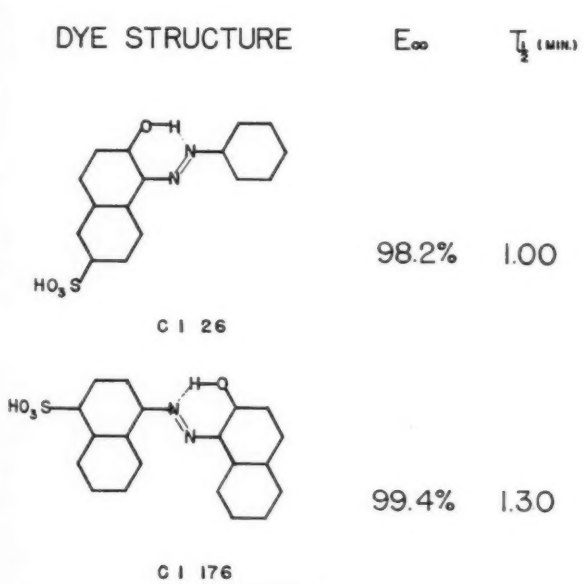

Figure 6
Effect of increasing the size of the hydrophobic end of the dye molecule on the rate of dyeing and equilibrium exhaustion

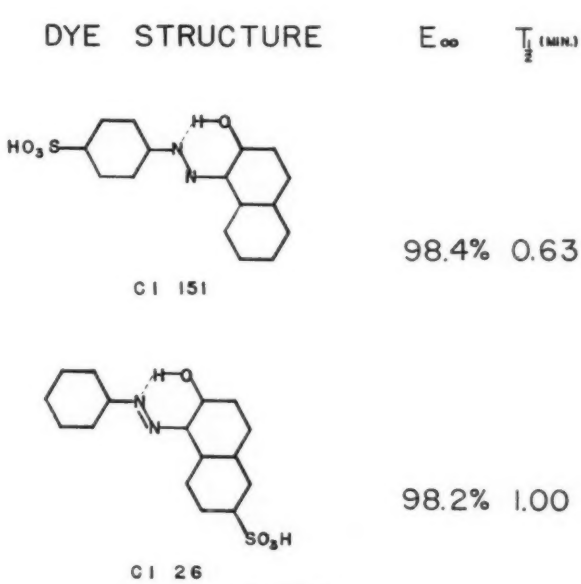

Figure 8
Effect of positioning of the sulfonic acid group on the rate of dyeing and equilibrium exhaustion

Colour Index Number	F	Log $t_{\frac{1}{2}}$
26 (S-N-A-B)	3.74	1.78
176 (S-N-A-N)	4.22	1.89
Difference:	0.48	0.11
% Difference:	11%	6%

A comparison of the "F" values again shows that the affinity of the larger dye molecule (#176) is greater than the affinity of the smaller dye molecule (#26), the larger dye molecule being 11% greater. However, it is also noted that the percent difference in the affinity

is the same as in the previous case where the size of the dye molecule was increased by the addition of a benzene ring on the hydrophilic end of the dye molecule. A comparison of the Log $t_{1/2}$ values shows that the overall rate of dyeing is decreased by the addition of a benzene ring on the hydrophobic end of the dye molecule, the decrease being only 6% as compared to 16% in the previous case. The results tend to suggest that the introduction of an additional benzene ring on the hydrophobic end of the dye molecule increases the equilibrium exhaustion and correspondingly the affinity for the wool fiber to the same degree as in the previous case where the increase in the size of the dye molecule was made on the hydrophilic end, but decreases the rate of dyeing by a smaller amount than in the former case.

3) THE EFFECT OF THE POSITION OF THE SULFONIC ACID GROUP———Two dyes, *Colour Index* numbers 151 and 26, were used; these dyes are identical in all respects except for the position of the sulfonic acid group. Number 151 has the sulfonic acid group on the benzene ring, whereas number 26 has the sulfonic acid group on the naphthalene ring (see Figure 8). The data for the dyeing process are given in Table I. Figure 7 shows a plot of fractional exhaustion against the square root of time comparing the dyeing behavior of these two dyes. Observation of this plot indicates that the two curves differ significantly in their dying rates.

Figure 8 compares the structural formulas of these two dyes, and their respective equilibrium exhaustion and time of half dyeing. It is evident from the comparison of the structural formulas that the dyes are identical except for the position of the sulfonic acid group which can also be looked upon as a difference in the shape of the dye molecule. A comparison of the $T_{1/2}$ values shows that a change in the position of the sulfonic acid group from the benzene to the naphthalene nucleus increases the $T_{1/2}$ value or decreases the rate of dyeing. This indicates that the shape of the dye molecule influences the rate at which dyeing takes place under these conditions. On the other hand; a comparison of the equilibrium exhaustion shows no significant difference in their values. The "F" values and the Log $t_{1/2}$ for these two dyes are as follows:

Colour Index Numbers	F	Log $t_{1/2}$
151 (S-B-A-N)	3.79	1.58
26 (B-A-N-S)	3.74	1.78
Difference:	0.05	0.20
% Difference:	1%	11%

It can be seen from the above comparison of the "F" values that the affinity of the dye for the wool fiber is not appreciably affected by the shape of the dye molecule. On the other hand, it is evident from the comparison of the Log $t_{1/2}$ values that the shape of the dye molecule appreciably affects the overall rate of dyeing, the difference being 11%.

The effects produced by the various acid dye structures on the affinity of the dye for the wool fiber and on the rate of dyeing may be summerized as follows:

Number of Carbon Rings	Colour Index No.	F	Log $t_{1/2}$
2	148	2.89	1.48
	1034	3.24	1.54
3	151	3.79	1.58
	26	3.74	1.78
4	176	4.22	1.89

Observation of the above table shows that the affinity increases, while the rate of dyeing decreases, with increasing number of carbon rings on the dye molecule. It is noteworthy that in the case of the anthraquinone dye (#1034) the anthraquinone linkage behaves partly, if not entirely, as a third ring. Although the values are not the same magnitude as the other three-membered rings, they tend to be in the proper direction. In the case of the dyes with three carbon rings, it is observed that the shape of the dye molecule does not affect the affinity as shown by the similarity of the "F" values for dyes number 151 and number 26, but appreciably influences the rate at which the dyeing takes place.

According to Speakman and Smith *(7)*, a linear relationship should exist in the early stages of the dyeing between the amount of dye taken up by the fiber and the square root of time. That this is so has been shown by Sakaguchi *(1)* and Chiklis *(2)* under the condition that the fibers are first allowed to come to equilibrium with the acid bath. Observation of Figures 1, 3, 5, and 7 shows that the data obtained in this investigation is in good agreement with the results obtained by these workers. In all cases the straight line portion of the curves, if extrapolated, approaches very closely to the origin of the plot.

CONCLUSIONS

From the results of this investigation, it can be concluded that:

1) The basic dye structure has only a small effect on the rate of dyeing, but appreciably affects the final equilibrium exhaustion. This effect may be due to the formation of a carbon ring.

2) The position of the sulfonic acid group or the shape of the dye molecule appreciably affects the rate of dyeing, but has no effect on the final equilibrium exhaustion.

3) The size of the dye molecule affects both the equilibrium exhaustion and the rate of dyeing, but the manner in which the size of the dye molecule is increased has a definite influence on the dyeing rate.

4) The greatest equilibrium exhaustion, but the lowest rate of dyeing, is obtained when the dye molecule is large.

5) The lowest equilibrium exhaustion, but the highest rate of dyeing, is obtained when the dye molecule is small.

6) In general, the data for all dyes agree fairly well with the theoretical relationship expressing the first half of the dyeing, but deviate from the theoretical relationship expressing the last half of the dyeing in a manner consistent with the number of carbon rings on the dye molecule.

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APPENDIX

The *Colour Index* numbers referred to in Figures 2, 4, 6, and 8 and in other parts of the above article apply to the old *Colour Index*.

The equivalents of these numbers in the new *Colour Index* are as follows:

Old CI No.	New CI No.
148	14270
1034	58005
151	15510
176	15620
26	15970

Rhode Island Section——

FIBERS AND EQUIPMENT USED IN THE MANUFACTURE OF NONWOVEN FABRICS*

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Brennan

The author discusses some of the newer descriptions of fibers and equipment used, and also mentions a few of the end uses which nonwovens have established themselves in today and their prospects for tomorrow.

HISTORY

THE oldest type of fabric known to man is an animal fibrous felt. Wool, mechanically felted, was used many years before history was recorded. The origin of nonwovens as we know them today can be traced to wool felts. It was not until the early 1940's that bonded nonwoven fabrics became synonomous with the accepted present-day terminology. Glazed wadding, the immediate forerunner of today's nonwovens, was processed on textile equipment as far back as 1860. It has been improved upon so greatly that today hundreds of patents cover techniques and processes for the manufacture of nonwoven fabrics. It has been estimated that the growth of nonwoven fabrics since 1945 has doubled at least every three years. The poundage of fibers used in nonwoven manufacture in 1956 has been estimated to be around 60 million. Fibers used include wool, cotton hairs, rayon, acetate, and the synthetic fibers, such as nylon, Orlon Acrilan, Dacron and others.

TYPES OF EQUIPMENT USED

Standard textile opening and blending equipment is used in the initial phases of nonwoven manufacture. It is just as important that the raw stock to be used in nonwovens be prepared as carefully as raw stock to be spun into yarns. After the proper opening and blending of fibers, there are many types of equipment used to form the web prior to its being bonded into a usable nonwoven fabric.

The most common types of web formers are cotton or woolen cards arranged in series or tandem. A single conveyor belt carries the superimposed webs from each card in the production line to the bonding equipment. With such multiwebs, the thickness and weight can be varied by the number of cards in the line as well as by the grain weight of each card web. Depending on the intended end use, it is possible that different fibers may be used on two or more of the cards in the series. For example, a coarse denier fiber could be used on the back cards with a fine denier fiber on the front cards. Thus one surface of the finished nonwoven fabric would be closed and tight while the coarse fibers would contribute bulk and porosity to the finished material. Strength would be predominatly in the machine direction of the web. The fibers could be said to be oriented.

Another method of forming a fiber mat suitable for nonwovens makes use of the cross lapper. By this means the web from a series of cards or garnetts is laid on the bias on a moving conveyor apron. This method of cross laying the web provides a more balanced strength in both the longitudinal and transverse directions of the finished mat than does the aforementioned method.

A combination of both methods is used to further equalize the strength in both the crosswise and the lengthwise directions of the finished mat. A cross lapper is used to lay down on the conveyor apron a web on top of a web or webs from a card series. This forms a finished mat with balanced strength in both directions. Not all nonwovens call for equal strength in two directions, but this does serve that purpose when called upon to do so. Such a method is not advantageous for lightweight nonwovens because of the many webs which are necessary to achieve this two-directional feature and the difficulty of overcoming cross lap ridges.

A combination of carding and air deposition to form an isotropic web in one operation is very effective. Commercial equipment is now available with these features. It forms a random dispersed web with weights that may be varied from ½ oz/sq yd to over 16 oz/sq yd.

Many concerns active in the manufacture of nonwoven fabrics have designed their own equipment simply because there was nothing suitable on the market. This equipment is essentially modifications of one of the above-mentioned types, or a combination of them, to process a finished mat for an intended end use. For example, Chicopee Mfg Co has a patent on a machine for producing an isotropic nonwoven web through use of an air stream. A B Dick Co has a patent on a method of dispersing fibers in enclosed air streams and collecting them in interfilled layers for forming bonded nonwoven material. Kimberly-Clark has a patent on an apparatus for forming nonwoven fiber webs by means of a combing drum and centrifugal discharging forces. West Point Mfg Co has a patent on the forming of nonwovens from a carded fiber and air forming the web on moving screen. There are many other patents covering the adaptation of new techniques too numerous to mention.

Before a company goes into the manufacture of nonwovens, it should know what type of product it would want to make. Then the type of equipment can be selected which will basically provide the final web properties desired. For instance, some nonwoven materials may call for high strength in the lengthwise direction and low strength in the crosswise direction. Thus a card or garnett series would be suitable. Where a

*Presented before the Rhode Island Section at the quarters of the Providence Engineering Society, Providence, RI, on March 28, 1957.

heavy product is desired, the cross-lapping machine would be beneficial.

Where uniform weight, thickness and strength in all directions is desired, such as nonwoven wearing apparel, then a combination of carding and air-deposition equipment would be in order. The costs of such equipment and the production by each method will vary. The tendency is toward higher speeds on all equipment plus wider widths, at the same time maintaining the quality of low-speed production.

There will also be new types of equipment or improvement on standard equipment to further the development of a growing industry. It has long been known that one of the basic drawbacks in card production has been the doffer comb. Production was in many cases limited to the speed at which the comb removed the web from the doffer. A roller type of comb has been developed, wherein the web is rolled off the doffer, allowing increased carding rates with little or no difference in quality of the web. There is a machine of this type developed by an English concern, which allows web takeoffs up to 100 yards per minute.

One of the machinery manufacturers feels that most of the current developments are being directed toward increasing the speed of the comb rather than making a radical change in the doffing mechanism. Air take off is being considered and under development.

A needle loom, although not new equipment, is being used to some extent in the manufacture of nonwovens. It provides more strength to a finished nonwoven. With the redesigning of the needle loom to accommodate the finer fibers and lighter weight materials at higher speeds, its future in the nonwoven field is bright.

FIBERS USED IN NONWOVENS

Fibers used in nonwoven manufacturing will vary also according to the end use of the product being manufactured. Originally, cotton and wool were the two predominant fibers used for nonwovens. Availability and equipment prompted their use. Drawbacks in their use were evident. Wool fabrics were expensive and had shrinkage characteristics which were objectionable. Cotton entailed much cleaning prior to web formation and in many instances did not give the strength or quality for the intended use. Many other basic properties of the natural fibers were not suitable for producing the desired product. With the introduction of the man-made fibers into the nonwoven field, a greater number of fiber properties and characteristics were made available. It was possible to engineer fibers for a particular end use or product. With rayon staple, for example, many features could be offered which would help to engineer a nonwoven fabric for a particular end use. It can be purchased in deniers ranging from 0.75 denier to 50 denier including 3.0, 5.5, 8.0 and 15.0 and if necessary, various deniers in between. This allows a freedom of fiber texture. Rayon staple is also available in crimp to promote bulk, web cohesion and strength in the finished mat. It can be purchased in lengths of from 1⅛" up to 5"—7". These fibers can also be dull, extra dull, or bright as the occasion demands. Thus, man-made fibers can be engineered for a particular end use. Natural fibers do not provide this versatility in fiber characteristics. For example, as a backing for vinyl film in side wall paneling in automobiles, it was necessary to have a nonwoven fabric which was resilient but light in weight and having a finished strength after bonding sufficient for lamination to vinyl film. Thus a coarse 15-denier rayon fiber was used in combination with the crimp to provide the necessary bulk and matt strength. Rayon, because of its price and the fact that it could be engineered served the purpose very well.

How about the other synthetic fibers? Nylon staple has much to offer because of its high abrasion-resistance qualities, its high strength features, its hydrophobic properties. It is being used quite extensively for engineering nonwoven products both in 100% form and in blends with cotton and/or rayon to provide these features to the finished web. Dacron, a polyester fiber, has aesthetic qualities to offer in a finished web especially if short-length fibers are used. It can also be used as a binder fiber because it is made with a low melting point. Where Dacron is used both as a binder as well as a base fiber, it provides a better bond than when used with other base fibers. Vinyon, a thermoplastic vinyl resin fiber with a low melting point, is used as a binder fiber in blends with rayon, cotton, wool, jute, etc and other synthetics. Other bonding fibers occasionally used are plasticized acetate and the acrylics. If glass fibers can be made to process on textile equipment by the addition of special finishes or crimp, they should find an important place in the nonwoven field.

Waste fibers and reprocessed fibers at first served as the main body of the nonwoven industry. Although they are currently being utilized today in substantial poundage, there is steady growth in the use of first-grade fibers because of the demand for quality nonwovens. By use of first-grade fibers, fabrics can be more readily duplicated, especially in the lighter weight constructions.

BONDING

Bonding techniques and methods used in nonwoven fabrics vary with the fibers used and the physical properties desired in the end product. Generally speaking, there are four accepted types of bonding media used in nonwoven fabrics.

1) Thermoplastic or low-melting-point fibers may be used in blends with other natural or synthetic fibers. By varying the degrees of heat and pressure, one can build in certain aesthetic or hand qualities which cannot be duplicated by other types of bonding agents.

2) Print bonding of the webs or discontinuous bonding is applied in stripes of a particular pattern so that most of the fabric is not bonded. This imparts a softness, a flexibility and absorbency which is often times desirable in a nonwoven fabric.

3) Saturation of the complete webs or matt is the third method. The carded material is drawn through an adhesive bath, squeezed to the correct resin pick up, and dried on hot slasher cans, hot air ovens or infrared heating bars or lights. Some adhesives require curing to secure the end product desired.

4) A fourth method calls for spraying of the carded webs or matts with an adhesive or solvent and allowing the material to be dried without pressure to maintain its resilience. Here lightweight fabrics of one ounce can be treated to give a high tear and a spring back or bounce, which is desirable.

Viscose or cellulose xanthate is a type of saturation bonding which is used to a great extent today. The webs are impregnated with the viscose solution and coagulated. The fabric is then washed, bleached and dried. Fibers may be dyed by introducing a fast pigment to the bonding solution. The advantage of this type of bonding is that the fabric can be washed and rinsed. It is fairly durable. Because of this it can withstand most

(Concluded on page P600)

Rhode Island Section———

COMPARISON OF WRINKLE-RESISTANT FINISHES FOR COTTON*

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A brief discussion is given on the mechanism by which wrinkle-resistant properties are imparted to cotton fabrics by the use of urea and melamine-type resins. A summary of the chemistry of these products is given. The results of an extensive study of the application of urea, modified urea (ethylene urea), melamine and modified melamine-formaldehyde resins using ammonium, alkanol amine, and metallic inorganic salt accelerators to cotton fabric are presented. The effect of variations in resin concentration, curing temperature and time on the wrinkle recovery, tensile strength, tear strength and discoloration of the treated fabric before and after washing is discussed. This work was designed and analyzed statistically to insure an accurate and authoritative presentation of the more important properties imparted to cotton fabric for the systems studied. These data should enable a cotton-fabric finisher to select the optimum resins and conditions of application to obtain the wrinkle-resistant finish best suited for the specific fabric properties desired.

HISTORY

HISTORICALLY, wrinkle-resistant finishes on cellulosic fabrics (8) had their start with the use of urea-formaldehyde and an acid-forming ammonium salt accelerator. The early work was primarily on rayon fabrics. The second important development in the wrinkle-resistant field was the application of melamine-formaldehyde to both rayon and cotton. Next came the use of the alkanol amine salt accelerators followed by the modified urea-formaldehyde (ethylene urea-formaldehyde). The more recent developments of importance are metallic salt accelerators and the modified melamine-formaldehyde.

A number of papers have been written on the properties of the finishes obtained on cotton fabrics using these different products; however, no really comprehensive comparison of them has been made so that the finisher can choose the particular system best designed for the specific fabric properties desired. The work described in this paper was carried out to make such data available.

CHEMISTRY

In order to have a better understanding of wrinkle-resistant finishes, let us briefly review the chemistry of urea and melamine-formaldehyde and possible mechanisms for explaining how wrinkle resistance is obtained.

Urea and melamine-formaldehyde used for imparting wrinkle resistance to cellulosic fabrics have been termed "thermosetting resins." Ethylene urea-formaldehyde has been called both a "resin" and a "cellulose reactant." Actually, in the form used for wrinkle-resistant finishes, these products are not resins but chiefly monomeric chemicals capable of both resin formation and reaction with cellulose.

Urea - formaldehyde (dimethylol urea) is tetrafunctional—has four reactive positions (the two hydroxyl groups and the two hydrogens attached to the two nitrogen groups) as shown in Figure 1. Melamine-formaldehyde (trimethylol melamine) as hexafunctional—has six reactive positions (the three hydroxyl groups and the three hydrogens attached to the amino nitrogens) as shown in Figure 2. Ethylene urea-formaldehyde is difunctional—has two reactive groups (the two hydroxyl groups) as shown in Figure 3. An ethylene urea-formaldehyde linear polymer is shown in Figure 4. Such a polymer was formed in our laboratory by merely heating monomeric ethylene urea-formaldehyde at 130°-135° C. (No accelerator was used since it would

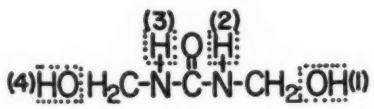

Figure 1
Dimethylol urea

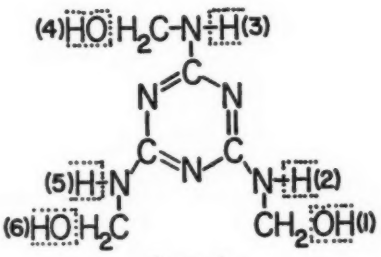

Figure 2
Trimethylol melamine

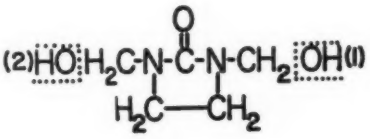

Figure 3
Dimethylol ethylene urea

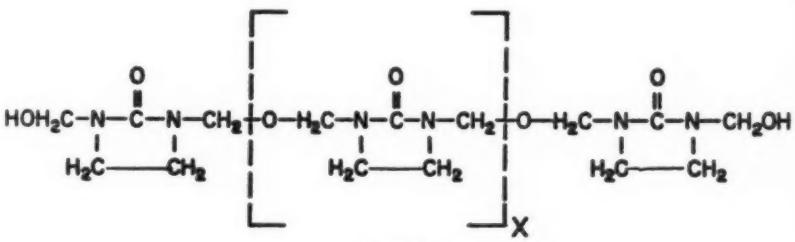

Figure 4
Ethylene urea-formaldehyde polymer

* Presented by T F Cooke before the Rhode Island Section on January 31 1957 at Johnson's Hummocks Grille, Providence, RI. This paper appeared originally in the February, 1957, issue of *Textile Research Journal*.

Figure 5
Urea-formaldehyde polymer, linear type

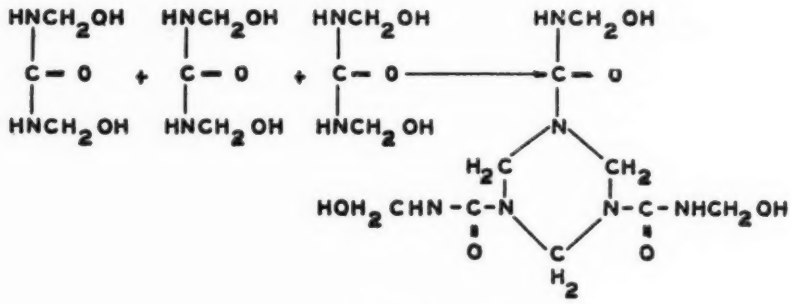

Figure 6
Urea-formaldehyde polymer, cyclic type

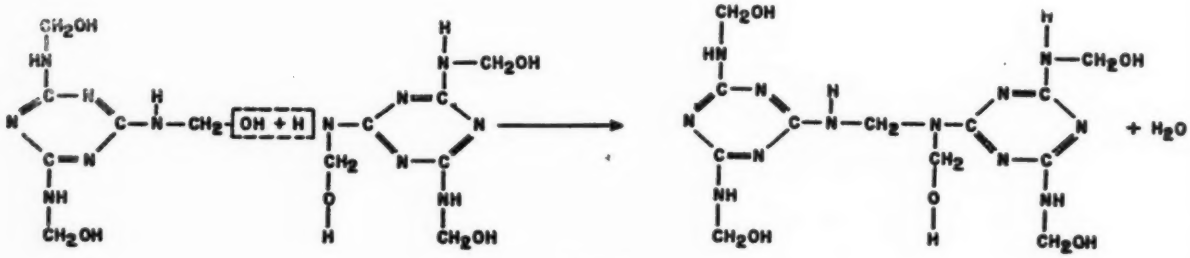

Figure 7
Melamine-formaldehyde polymer, linear type

interfere with the subsequent molecular weight determination made on the product.) In four hours a product with an average molecular weight of 2,500, corresponding to a linear polymer averaging 17 units long, was formed.

Two ways that monomeric urea-formaldehyde can condense with itself to form polymers (9) are shown in the next two figures. Three molecules of dimethylol urea are pictured in Figure 5 as condensing to form a linear trimer. This condensation reaction can, of course, continue in the same manner to form a chain polymer. Three molecules of dimethylol urea are shown condensing to form a ring trimer in Figure 6. Further condensation in this manner is, of course, possible with the formation of a polymer of ring trimers. It can be seen that polymers of a variety of structures are possible with the condensation of urea-formaldehyde monomers to form chain or ring polymers or combinations of the two. Similar chain and ring polymers (9) can be formed from melamine-formaldehyde monomers as shown in Figures 7 and 8, respectively.

Melamine, urea and ethylene urea-formaldehyde can react through the methylol group with a hydroxy group of cellulose by means of an ether linkage (2). Infrared spectra of melamine - formaldehyde - treated cellophane films have indicated that such

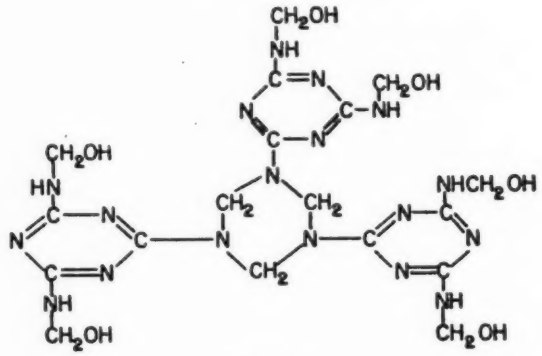

Figure 8
Melamine-formaldehyde polymer, cyclic type

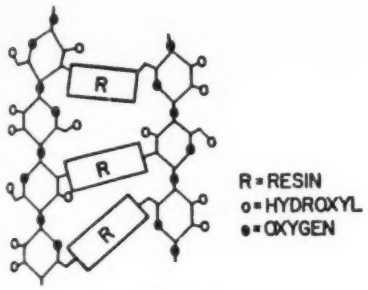

Figure 9
Crosslinking of resins to cellulose

a chemical reaction may occur (*2, 5*). It has been postulated that the "resin" molecules or "reactants" cross link adjacent cellulose chains in the amorphous regions within a cotton fiber (*1, 2, 3*). Figure 9 pictures such a cross linking.

Although it is conceivable that wrinkle resistance could be obtained as the result of resin formation within the cotton fiber, it is believed that it primarily results from cross linking between adjacent cellulose chains (*1, 2, 3*). Such a cross-linking process would tend to prevent the cellulose chains from slipping irreversibly past one another under the influence of an applied stress. The prevention of this irreversible slippage reduces the permanent set of a cellulosic fiber, thereby increasing its elasticity and imparting wrinkle resistance (*2*). This increase in elasticity of the fiber is carried through to the fabric as shown in Figure 10, which gives the load extension curves for the untreated and urea-formaldehyde counterparts (*2*).

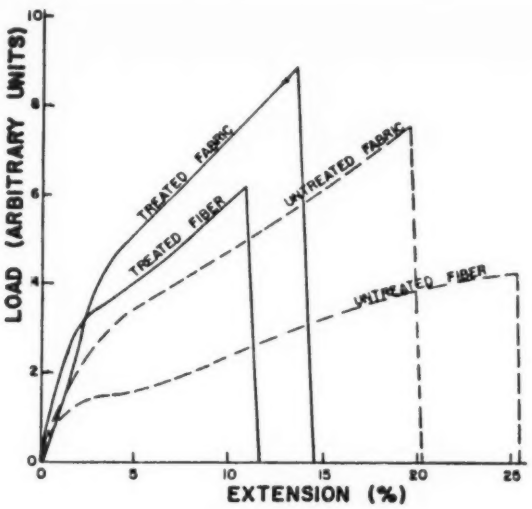

Figure 10
Stress-strain curves for treated and untreated rayon fiber and fabric

EXPERIMENTAL

The "resins" studied included the most extensively used types. The concentration of these products applied to the fabric was varied over a wide range to include not only the normally used concentrations but lower and higher solids as well as shown in Table I.

The accelerators studied included the most extensively used types. The accelerators were applied at those concentrations generally found to give optimum wrinkle-recovery values as shown in Table II. All accelerator concentrations are expressed in terms of active ingredients.

Each "resin" was applied with each of the accelerators, giving a total of twelve "resin" accelerator systems studied. The "resins" were applied to bleached, unmercerized, 80x80 cotton. The untreated fabric had a pH value of 6.8. The treated fabric was dried and then cured at temperatures ranging from 275° F to 365° F at times varying from 0.75 to 8.25 minutes. This range of time and temperature of cure was chosen to represent not only those conditions usually considered optimum but also conditions of less as well as more cure.

The data used in this paper were obtained by statistical means. The actual experiments were statistically designed to afford maximum efficiency for every individual experiment as well as to insure the most accurate, precise and unbiased data. The design was of such a nature as to exclude errors which are normally encountered in experimental work. Some of the errors which were eliminated by cancelling-out effect are the errors due to differences in the physical properties of the fabric used for treatment; variations in processing equipment from day to day; fluctuation in apparatus as well as differences between operators used in the application and the testing of the treated fabrics.

At the start of the experimentation it was necessary to evaluate the physical properties of cloth samples taken from approximately two miles of 80 x 80 cotton fabric in order to obtain 0.7 of a mile of fabric, the physical properties of which were closely similar. The 0.7 of a mile of fabric was divided into 216 individual lengths to receive 216 resin treatments.

The treated fabric was tested for the properties shown in Table III.

The wrinkle recovery, tensile strength and discoloration properties were evaluated after a process wash and after a number of washes in a Najort washing machine at a temperature of 140° F using 0.1% neutral soap and 0.02% available chlorine.

The data were then collected and subjected to a statistical analysis. The analysis for the most part was carried out on a high speed electronic computer which utilized over 300 sq ft

TABLE I
"Resins" Studied

"Resin"	Designation	% on wt of fabric
Urea-formaldehyde (Aerotex Cream 450)	UF	4–20
Ethylene urea-formaldehyde (Aerotex Resin EU)	EU	2–11
Melamine-formaldehyde (Aerotex Resin M-3)	MF	2–11
Modified melamine-formaldehyde (Aerotex Resin MW)	modified MF	2–11

TABLE II
Accelerators Studied

Accelerator	Chemical composition	% on resin solids
Ammonium salt	ammonium sulfate	3.5
Alkanol amine salt	2-amino-2-methyl propanol-1 hydrochloride	7
Metallic inorganic salt	magnesium chloride	12

TABLE III
Fabric Properties Studied

Wrinkle recovery (CCC-T-191 b, Method 5212)
Tensile strength (CCC-T-191 b, Method 5100)
Tear strength (Elmendorf) (CCC-T-191 b, Method 5132)
Discoloration due to curing
Yellowing due to chlorine bleaching

of paper to record the resulting relationships between the variables under investigation and the physical properties obtained. It is estimated that the calculations would have required 20 years for one man had not the electronic computer been available.

In all cases, mathematical relationships were found to exist between the many physical properties tested and the variables of resin concentration, time of cure, and temperature of cure. A high statistical confidence in these relationships was realized because of the small fluctuations between the many control points which were randomly scattered throughout the 216 trials. Thus, it is possible to accurately compare the physical properties of the different resin-accelerator systems.

Ordinarily one can show a relationship between one independent variable by means of a graph of the two variables. Three variables can be included in a similar graph, in which the ordinate represents one variable, the abscissa a second variable and the third variable is plotted against the other two variables using lines of equal value. In this particular investigation, three variables were studied, and in order to graphically show the relationship between the three variables and a physical property such as wrinkle recovery it was necessary to use a three-dimensional model. Figure 11 is a diagram of such a model—a cube in which the axes represent the three variables. The modified MF "resin" and alkanolamine hydrochloride accelerator system is presented in this three-dimensional model. The time of cure is represented by planes parallel to the front of the cube; the temperature of cure is plotted as planes parallel to the base of the cube; and the resin concentration is represented by planes parallel to the sides of the cube. The curvilinear surfaces represented by slices through the cube have equal wrinkle-recovery values. In other words, all points on each one of these surfaces have the same wrinkle-recovery values (warp plus fill) showing that a given wrinkle recovery can be obtained by a combination of many different time, temperature, and resin-concentration relationships. Some of the important relationships are readily apparent. For example, the wrinkle recovery increases as the "resin" concentration increases. The wrinkle recovery in general increases as the time of cure increases and as the temperature of cure increases. There are exceptions

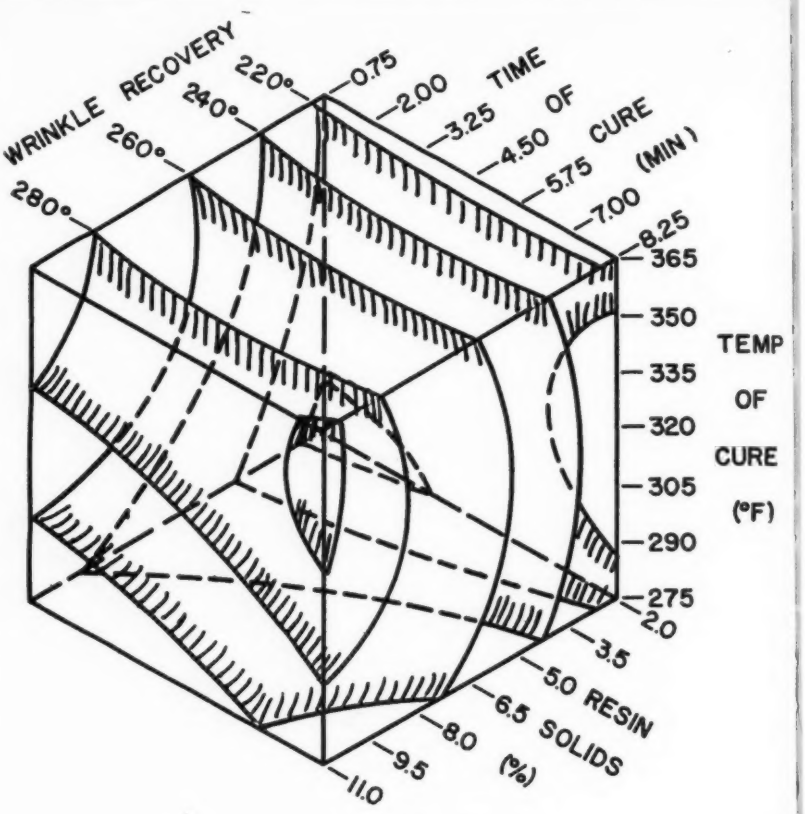

Figure 11
Diagram of a three-dimensional model of relationship between processing variables and wrinkle recovery

to these generalities for this particular system. A study of the top face of the cube, which represents the condition where the curing temperature is held constant at 365° F while the "resin" concentration and time of cure are varied, shows that the wrinkle recovery is not appreciably affected by variations in the time of cure since the wrinkle-recovery lines on this face are almost straight while the time of cure varies from 0.75 minutes to 8.25 minutes. This unusual relationship would not have been found by conventional studies of such a system. Similar cubes representing wrinkle recovery could be drawn for the additional eleven systems studied. However, the results will be plotted in two-dimensional graphs since they are more readily understandable. Only the most important of the vast volume of data collected will be shown.

PROPERTIES OF TREATED FABRIC

WRINKLE RECOVERY——The effect of resin concentration on the wrinkle recovery imparted by various resin-accelerator systems is shown in Figure 12. In this figure, the curing conditions are held constant at 1.5 minutes at 350° F. The effect of accelerator on the wrinkle recovery is shown to be as follows:

1) The ammonium salt gives the lowest wrinkle recovery values for each "resin."
2) The metallic inorganic salt is the most efficient for the MF.
3) The alkanolamine hydrochloride is the most efficient for the modified MF.
4) All three accelerators are effective for EU with the alkanolamine hydrochloride being slightly better than the ammonium salt, while the metallic inorganic salt is slightly superior to the alkanolamine hydrochloride.

These data show that: EU gives the highest wrinkle recovery and UF gives the lowest wrinkle recovery. The wrinkle-recovery values with UF reach a maximum at 12-15% solids and then decrease. This decrease is probably due to the increase in the stiffness of the fabric at the very high concentrations of "resins."

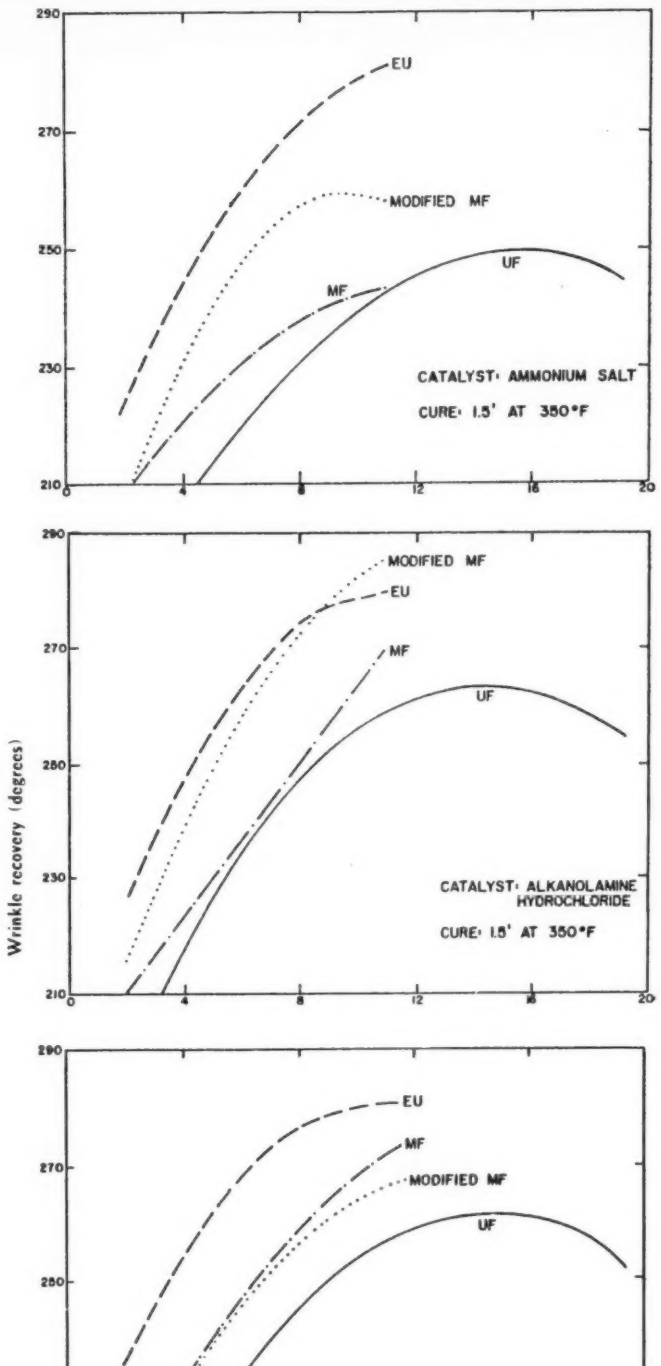

Figure 12
Effect of resin concentration on wrinkle recovery imparted by various resin-accelerator systems

The melamine "resins" give intermediate wrinkle-recovery values. When the alkanolamine hydrochloride accelerator is used with the modified MF, however, essentially the same wrinkle recovery is obtained as found with the EU.

There are four possible explanations for the difference in wrinkle-recovery values obtained for a given weight concentration of "resin":

1) The relative amounts of "resin" inside the fiber and outside the fiber caused by differences in size of the resin molecules.
2) The difference in the molecular weight of the monomers.
3) The amount of resin polymerized within the fiber compared to that reacted with the cellulose.
4) The difference in the length of cross link between adjacent cellulose chains.

It is not believed that reason "1" is the important factor since all four "resins" are chiefly monomeric. The monomeric molecules are sufficiently small to enter the fiber if we accept gas-absorption measurements of the pore size of cotton fibers *(4)*. Wrinkle-recovery plots based on concentration of molecules containing two or more methylol groups, rather than weight concentration, indicate that factor "2" is the most important one. Figure 13 gives such a plot for all four resins cured at 1.5 minutes at 350° F using a metallic inorganic salt accelerator. The fact that the curves for all four resins make up essentially one curve, shows that equal wrinkle recovery is obtained for the same concentration of molecules with two or more methylol groups. These data are in keeping with the concept that wrinkle recovery is obtained through the cross linking of adjacent cellulosic chains.

The wrinkle recovery obtained with the different "resin"-accelerator systems varies with the curing conditions. There are three ways in which the wrinkle recovery can respond to changing curing conditions. Figure 14, which represents the modified MF —ammonium salt system, shows that the wrinkle recovery increases as the time or temperature of curing increases. Figure 15, which pictures the EU-alkanolamine hydrochloride system, shows that the wrinkle recovery can be practically unaffected by varying the curing conditions. A third possibility is illustrated in Figure 16, which shows the EU-ammonium salt system. Here the wrinkle-recovery value increases to a maximum as the temperature increases to 320° F. As the curing temperature is increased

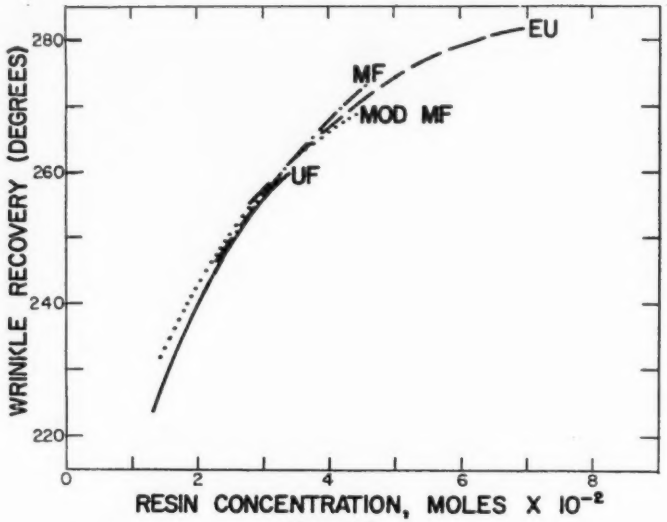

Figure 13
Relationship of molecular concentration to wrinkle recovery

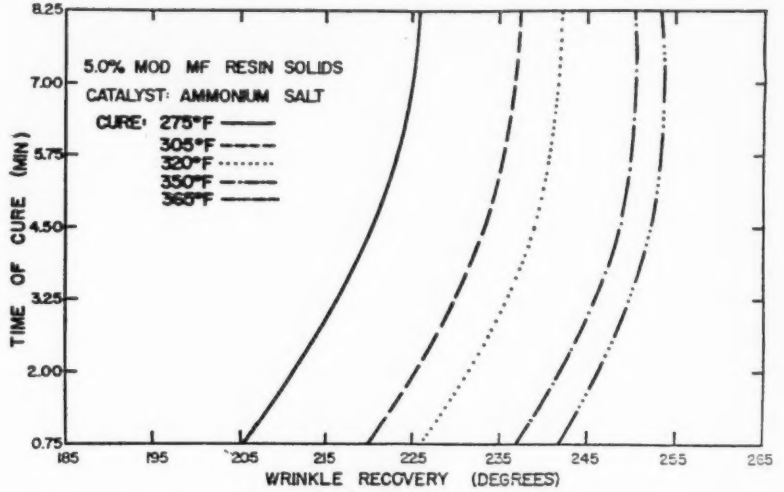

Figure 14
Effect of curing conditions on wrinkle recovery using modified melamine-formaldehyde —ammonium salt system

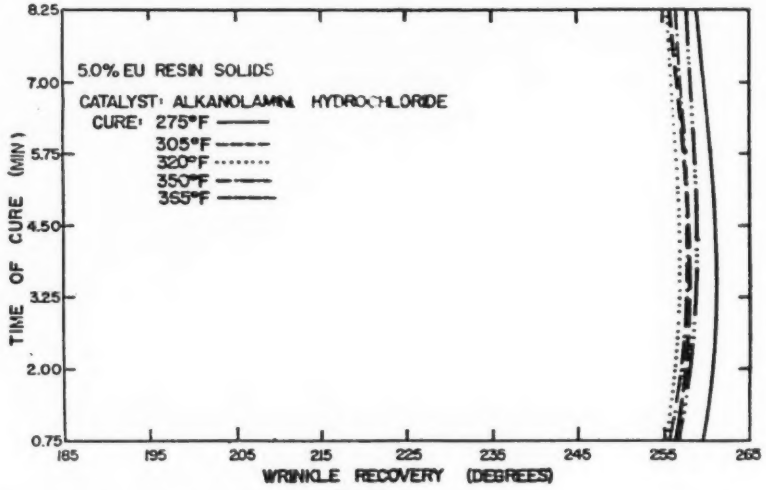

Figure 15
Effect of curing conditions on wrinkle recovery using ethylene urea-formaldehyde— alkanol amine hydrochloride system

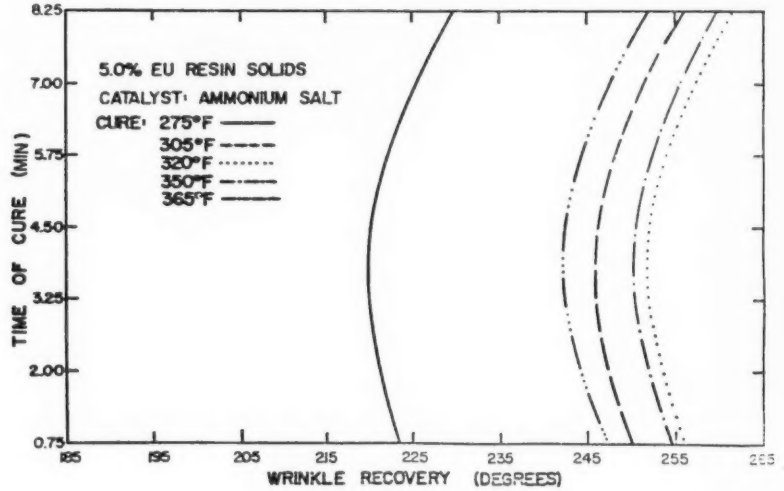

Figure 16
Effect of curing conditions on wrinkle recovery using ethylene urea-formaldehyde— ammonium salt system

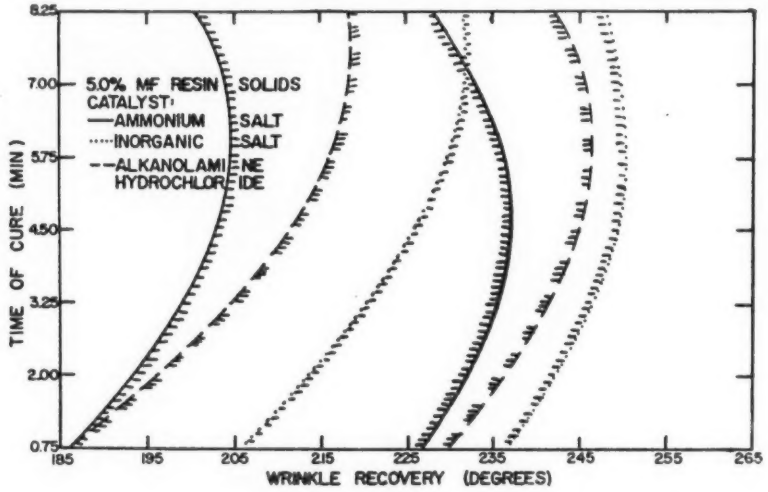

Figure 17
Effect of curing conditions on wrinkle recovery using various accelerators with melamine-formaldehyde

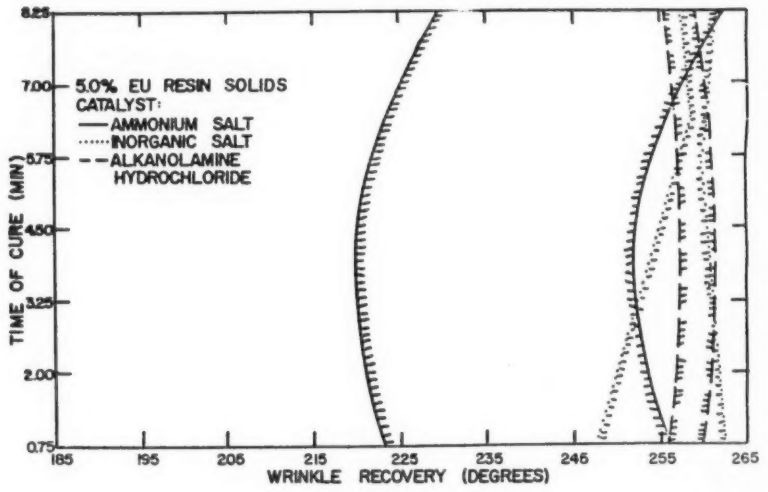

Figure 18
Effect of curing conditions on wrinkle recovery using various accelerators with ethylene urea-formaldehyde

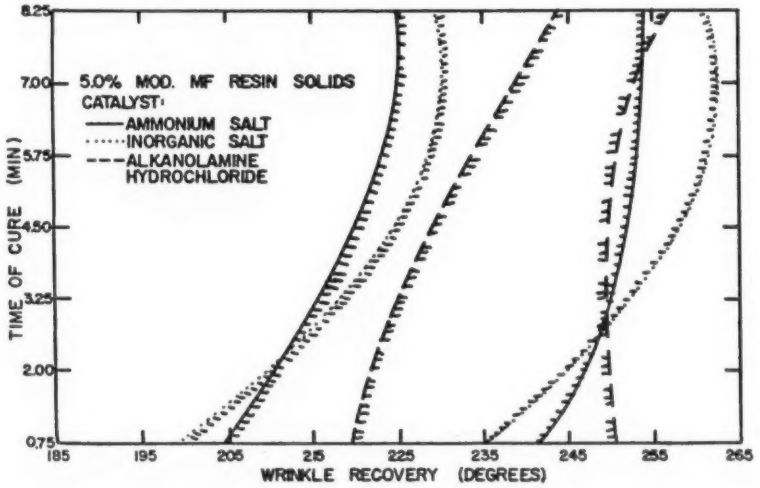

Figure 19
Effect of curing conditions on wrinkle recovery using various accelerators with modified melamine-formaldehyde

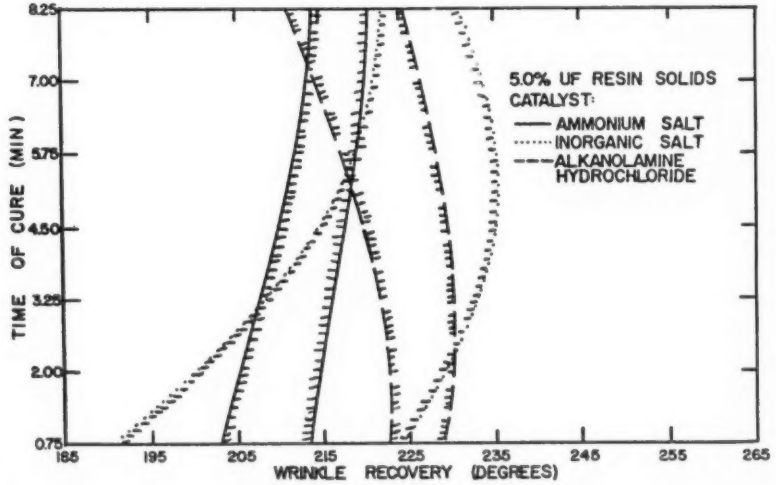

Figure 20
Effect of curing conditions on wrinkle recovery using various accelerators with urea-formaldehyde

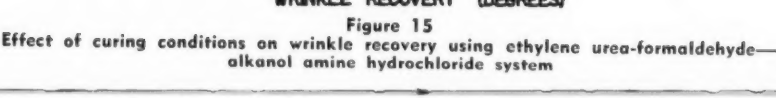

Figure 15
Effect of curing conditions on wrinkle recovery using ethylene urea-formaldehyde—alkanol amine hydrochloride system

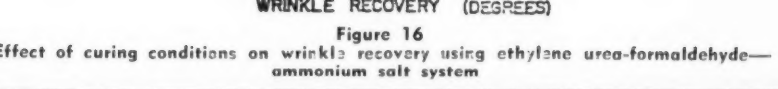

Figure 16
Effect of curing conditions on wrinkle recovery using ethylene urea-formaldehyde—ammonium salt system

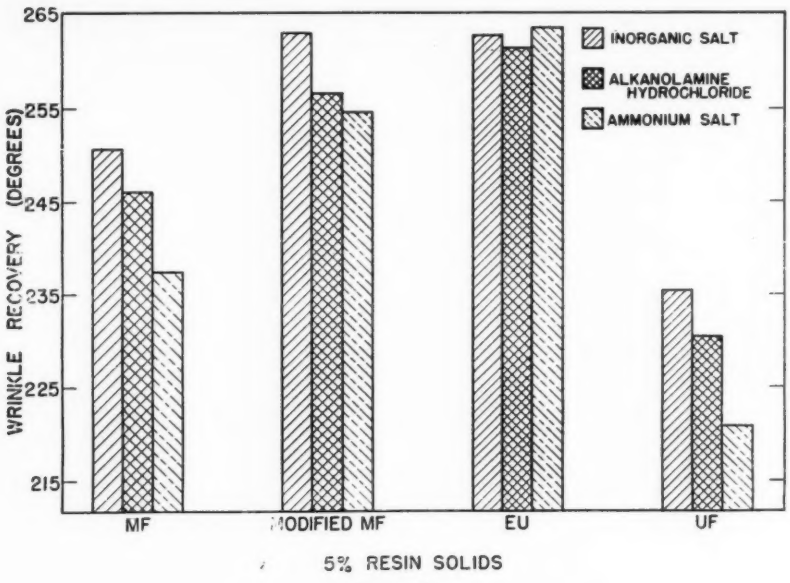

Figure 21
Maximum wrinkle recovery obtained with resin-accelerator systems

above 320° F, lower wrinkle recovery values are obtained. The lower wrinkle recovery at the higher curing temperature is probably due to hydrolysis of the "resin" through overcuring. Nitrogen determinations of the process-washed treated cloth support this idea; the nitrogen content of the fabric cured at 365° F being less than that of the fabric cured at 320° F.

The effect of curing conditions on the wrinkle recovery obtained with 5% resin solids in each of the 12 systems studied is summarized in Figures 17 through 20.

The MF systems are shown in Figure 17. The areas between the like curves represent the range of wrinkle recovery obtained within the curing conditions studied for each accelerator. The metallic inorganic salt gives the highest wrinkle recovery and the ammonium salt gives the lowest wrinkle recovery, but there is much overlapping of the areas. For wrinkle recovery values of 200°-225°, for example, any of the accelerators can be used; the choice being dictated by the effect of the accelerator on other fabric properties or economics.

In Figure 18, the EU systems are summarized. The ammonium salt generally gives the poorest wrinkle recovery and the area covered by this accelerator does not overlap the areas of the other accelerators to any great extent. The alkanolamine hydrochloride and metallic inorganic salt gives substantially the same wrinkle recoveries. The wrinkle-recovery values are quite high, about 250° to 265°. The time and temperature of cure have little effect on the wrinkle recovery obtained with the amonium nolamine hydrochloride or the metallic inorganic salt. The time of cure has little effect on the wrinkle recovery obtained with the ammonium salt, but the temperature is important, as is shown in Figure 16. These data indicate that with the metallic inorganic salt and alkanolamine hydrochloride, the time and temperature of cure of the EU do not have to be controlled within narrow limits for optimum wrinkle recovery.

In Figure 19, the wrinkle recovery obtained with 5% of modified MF is shown. Although there is considerable overlapping of the areas produced by the various accelerators, the metallic inorganic salt accelerator gives the highest wrinkle-recovery values at long times of cure. These data appear to be in sharp contrast to the data for a 1.5-minute cure at 350° F given previously, which showed that alkanolamine hydrochloride gave higher wrinkle recovery than the other accelerators. However, it can be seen that in Figure 19, also at short times of cure, the alkanolamine hydrochloride gives the best results.

In Figure 20, the wrinkle-recovery values of cotton fabric treated with 5% UF is shown. The metallic inorganic salt curves generally overlap the others. Again the ammonium salt generally gives the poorest wrinkle recovery and the metallic inorganic salt gives the highest wrinkle recovery under most conditions.

The maximum wrinkle recovery obtained with a given resin and accelerator combination at 5% solids was read from Figures 17-20 and shown in bar graphs in Figure 21. This summary shows that the metallic inorganic salt gives a wrinkle recovery value equal to or greater than that obtained with the other accelerators with all four "resins." The ammonium salt accelerator gives the lowest wrinkle recovery for all the "resins" except for EU, where it is equal to that obtained with the metallic inorganic salt. The modified MF and EU "resins" give the highest wrinkle recovery while the UF gives the lowest wrinkle recovery. In interpreting the data in Figure 21, one must be careful. The maximum wrinkle recovery may have been obtained, but other fabric properties such as the color, for example, may be unsatisfactory, as will be shown with subsequent data.

Figure 22 shows the durability of wrinkle recovery to repeated washes in a Najort washing machine at 140° F using 0.1% neutral soap and 0.02% active chlorine.

These graphs show that, in general, the melamine "resins" have greater durability than the ureas. Neither of the melamine "resins" shows an appreciable decrease in wrinkle recovery after repeated washes when the metallic inorganic salt accelerator is used. When the melamine "resins" are applied with the alkanolamine hydrochloride accelerator, the MF shows excellent durability and the

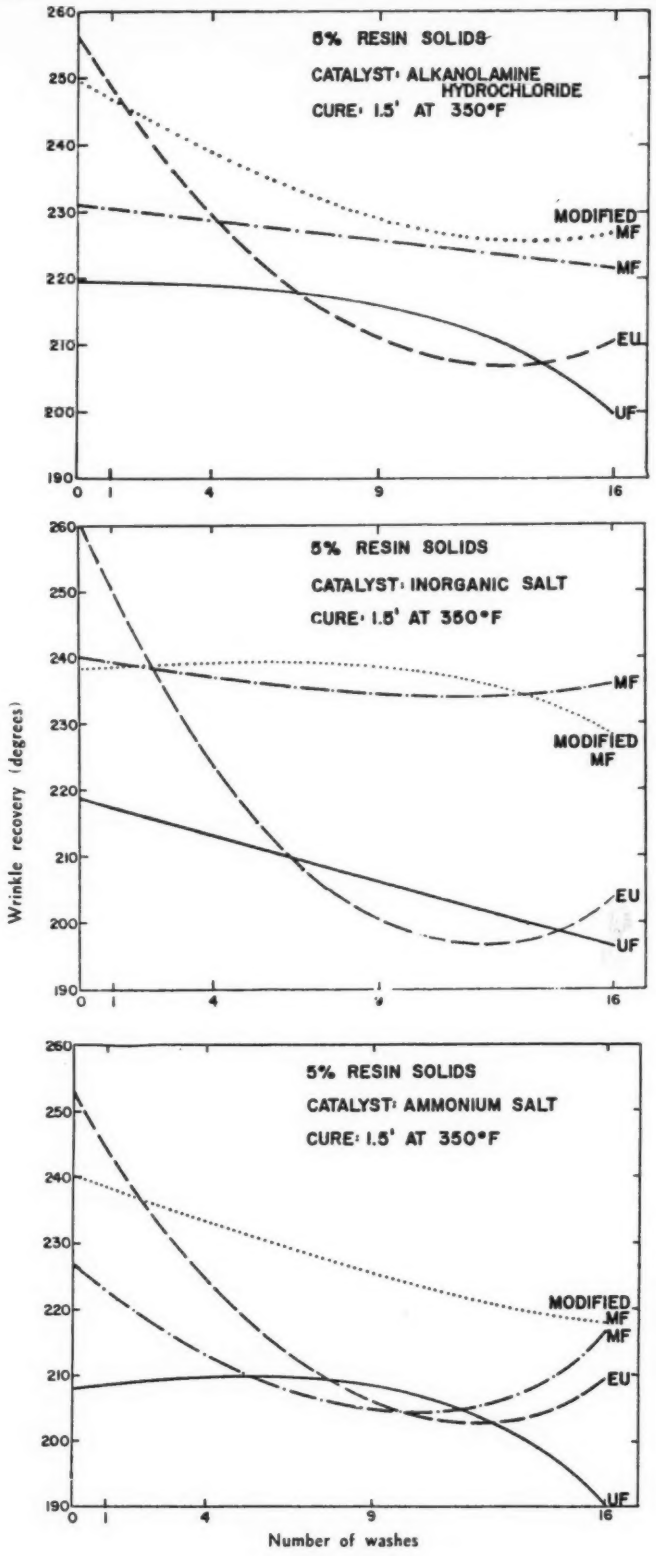

Figure 22
Durability of wrinkle recovery to chlorine washing using various accelerators

modified MF has only a slight loss in wrinkle recovery after repeated washes.

Although the wrinkle-recovery values of the EU finish are very high initially, they generally show the greatest loss after repeated washes. As these graphs show, the EU finish loses from 40-60% in wrinkle recovery after 16 washes. The UF finish has low initial wrinkle recovery and loses about 20% in these washes.

It is doubtful if the small increases in wrinkle recovery during the last few washes shown in certain systems in Figure 22 are real since the precision of the data is less as the number of washes increases.

The durability of a finish to washing can also be measured by the "resin" solids remaining on the fabric. To facilitate a comparison of the durability of the four "resins" in this manner, nitrogen determinations were made before and after 16 chlorine washings of two concentrations of UF, EU, MF and modified MF at a cure of 4.5 minutes at 320° F using the metallic inorganic salt accelerator.

The afterwash - nitrogen values were converted to the percent "resin" remaining on the fabric and plotted in Figure 23. It can be seen that the average resin retained after 16 of the chlorine-containing washings is approximately 30% for UF, 50% for EU and 80% for MF and modified MF.

The relative durabilities of the urea- and melamine-formaldehyde finishes to washing in the presence of chlorine can be explained by the relative differences between the rate of acid hydrolysis of these two classes of finishes. EU and UF "resins" can be much more rapidly removed from cotton fabric than MF "resin" in water containing 1.5% of 85% phosphoric acid and 5% of urea at 85° C, as shown in Figure 24. The acid resulting from the chlorine absorbed through washing would be expected to similarly hydrolyze the UF and EU finishes much more rapidly than the MF finish.

TENSILE STRENGTH——The effect of resin finishing on tensile strength has been the subject of considerable study. Figure 25 presents data showing the effect of increasing resin solids on the tensile strength. As can be seen, UF and MF finishes have higher strength than the other "resins" at any given solids. The EU finish has the lowest strength.

Most of the work that has been published comes to the general conclusion that, as the wrinkle recovery is increased, the tensile strength is

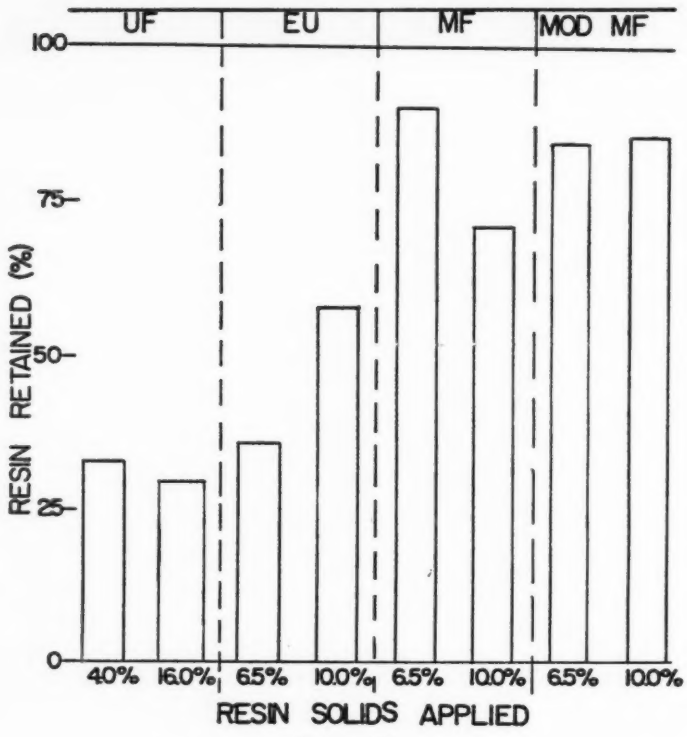

Figure 23
Resin retention after 16 chlorine washes

decreased. Many references state that there is a direct relationship between these two properties. Recent work by Stam (6) showed that ethylene-urea-formaldehyde finishes produce a greater loss in tensile strength than do melamine-formaldehyde finishes at equal wrinkle recovery. Our work supports this view. Plots of wrinkle recovery against tensile strength are given in Figure 26. The EU and modified MF finishes have a lower tensile strength than the other finishes at equal wrinkle-recovery values. In general, the rate of strength loss with increasing wrinkle recovery is greater for EU than for modified MF. With the metallic inorganic salt accelerator, it is interesting to note that the graph for the MF finish shows that there is no appreciable change in strength as the wrinkle recovery increases. The strength (warp plus fill) remains fairly constant at about 58-60 pounds. These data indicate that, when the tensile strength of the treated fabric is critical, the MF with the metallic inorganic salt should be considered for finishing the fabric.

There are two possible explanations for the differences in the tensile strength—wrinkle recovery relationship between the "resins," namely:

1) Physical bonds caused by polymer formation within the cotton fiber rather than covalent chemical bonds across adjacent cellulose chains.
2) The difference in the length of cross linking bonds.

If it were assumed that physical bonds permitted greater extensibility than covalent chemical bonds, the first explanation would appear to be a valid one. The authors know of no data that would justify making such an assumption, however.

On the other hand, it is conceivable that the difference in tensile strength between MF- and EU-finished fabric, for example, is caused by a longer "cross link" of the MF compared to that of the EU. If the monomeric MF and EU directly "cross link" adjacent cellulose chains, the MF "cross link" would be longer than that of the EU. If, with its greater functionality, the MF polymerizes more than the EU before "cross linking," the length of the "cross link" might be expected also to be greater than that of the EU. With a longer "cross link," greater extensibility resulting in greater tensile strength might be expected.

The effect of repeated chlorine washes on tensile strength is shown in Figure 27. As can be seen, the UF-finished fabrics generally show the greatest strength loss with repeated washes. The melamine-fin-

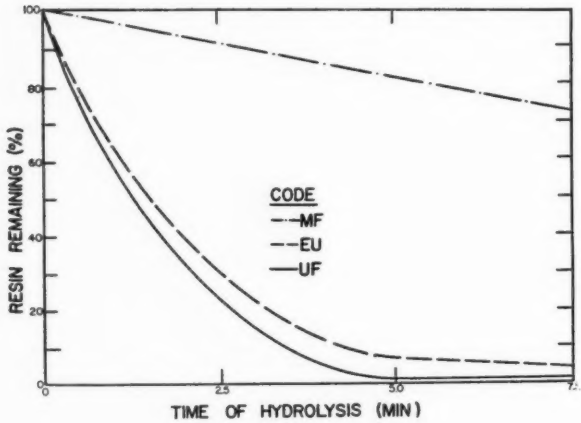

Figure 24
Acid hydrolysis of resin finishes

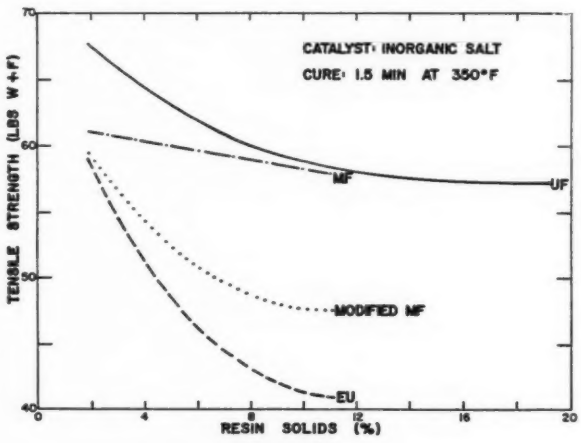

Figure 25
Effect of resin solids on tensile strength

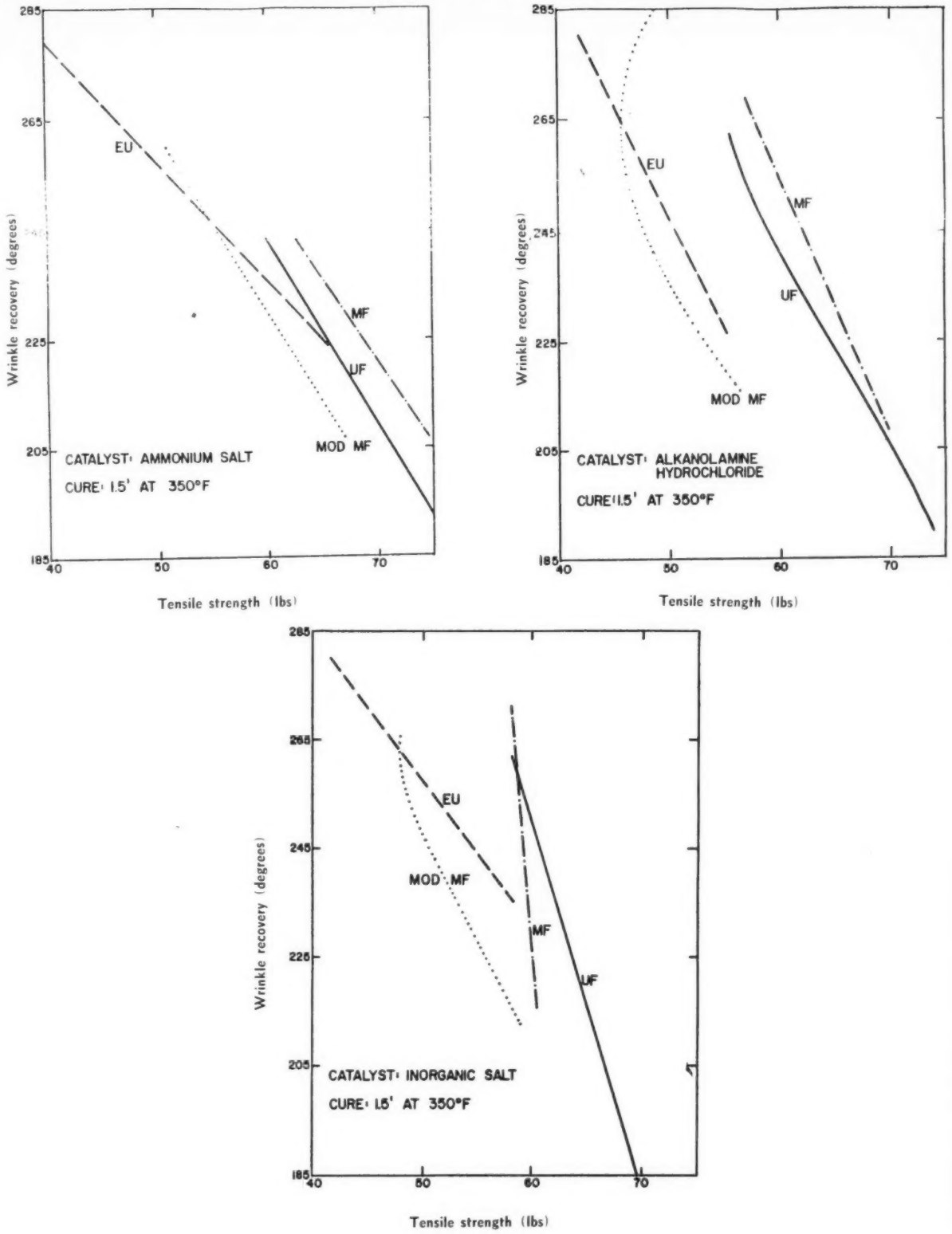

Figure 26
Relationship of wrinkle recovery to tensile strength using various accelerators

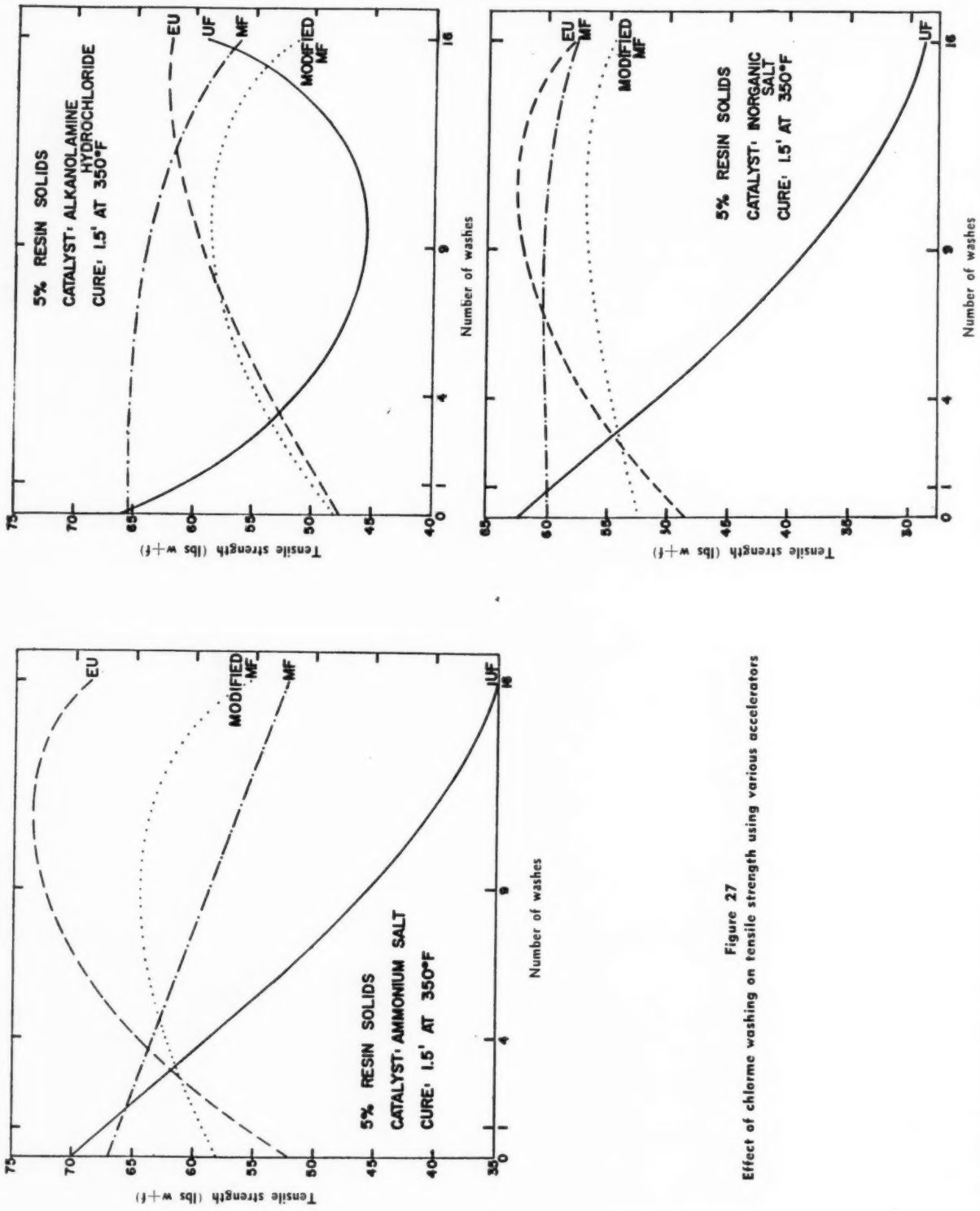

Figure 27
Effect of chlorine washing on tensile strength using various accelerators

ished fabrics in most cases show the least change in strength with repeated washings. The EU-treated fabrics generally increase in strength as washing proceeds.

There seems to be an apparent inconsistency in the increase in tensile strength for the EU finish and the decrease in tensile strength for the UF finish whereas both finishes show decreasing wrinkle recovery on repeated washes. An explanation for this apparent anomaly is that the UF has retained a considerable amount of chlorine, which has caused degradation of the cotton fabric. The EU finish, on the other hand, did not absorb enough chlorine to degrade the fabric, but enough was absorbed to hydrolyze the "cross links" with cellulose, thus recovering part of the original strength of the fabric and reducing the wrinkle recovery.

The comparatively small changes in tensile strength of the melamine-"resin"-finished fabrics on repeated chlorine washings is in keeping with their comparatively small changes in wrinkle recovery during the same washings.

The data in Table IV show that, after one chlorine wash, the amount of chlorine absorbed by the EU and melamine finishes is much less than that absorbed by the UF finish.

TABLE IV
Chlorine Absorption of "Resin"

Resin	Solids	% available chlorine
UF	4.2	0.4
	10.2	0.7
EU	6.5	0.1
	10.2	0.1
MF	6.5	0.1
	10.2	0.1
Modified MF	6.5	0.1
	10.2	0.1

If it is assumed that the chlorine absorbed by the "resin" eventually is converted into acid, the poor durability to chlorine washing of the UF and EU finishes would be expected because of their ease of acid hydrolysis. The comparatively high chlorine content of the washed UF-finished fabric is in accord with the explanation that its tensile strength loss is caused by degradation of the fabric from the action of chlorine.

The bar graph in Figure 28 summarizes the influence of chlorine on tensile strength as determined by the AATCC accelerated chlorine test (7) as a function of "resin," accelerator, and curing temperature. UF-finished fabric does not have any appreciable resistance to chlorine as determined by this test. Fabrics

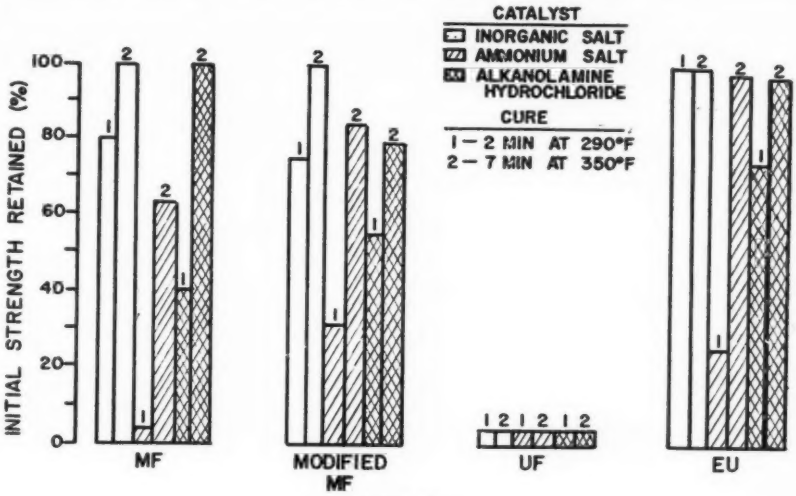

Figure 28
Effect of AATCC accelerated chlorine retention test on tensile strength of resin finishes

treated with "resins" cured at 290° F with the ammonium salt lose most of their strength under the test conditions. With other accelerators, particularly the metallic inorganic salt, at the high temperature, the melamine- and EU-"resin"-treated fabrics retain most of their strength when exposed to the high chlorine concentration of this test followed by scorching.

DISCOLORATION ——— A fabric may discolor during resin treatment or during washing in the presence of chlorine bleach. A photometric method for quantitatively determining a yellow discoloration has been developed. This method involves measuring the percent reflectance at 455 (R_1) and 557 (R_2) mμ and calculating the Yellowing Index by the following formula:

$$\text{Yellowing Index} = 70\left(1 - \frac{R_1}{R_2}\right)$$

A Yellowing Index value of about 3 indicates a very small degree of yellowing. In fact, the yellowing of a fabric at this value can only be seen by comparing it with a white standard. A Yellowing Index of 5 is visible with close inspection. Yellowing Index values of above 5 are easily seen.

Initial yellowing (resulting from curing—not chlorine bleaching) is affected by the time and temperature of the curing cycle.

Figure 29 shows the effect of increasing temperature on the discoloration for the different resin-accelerator systems. In general, the degree of initial yellowing tends to increase with increasing temperature. The rate of increase and the degree of yellowing is lowest when the metallic inorganic salt accelerator is used. At the higher temperatures EU generally yellows most.

Figure 30 shows the effect of curing time at 350° F on initial yellowing. As can be seen, the degree of initial yellowing increases with increasing cure time. Here again, resins applied with the metallic inorganic salt yellow the least. EU-finished fabrics yellow more than the other "resin" finishes when alkanolamine hydrochloride and ammonium salt accelerators are used.

Figures 31 and 32 show the discoloration due to chlorine washing (not initial yellowing) on melamine-"resin"-finished fabrics only. No data are presented for the EU or UF finishes since these do not yellow with chlorine washing.

Figure 31 shows the effect of variation of curing conditions on yellowing of MF-treated fabric due to chlorine retention after 16 chlorine washes. Increasing the curing temperature or time generally decreases yellowing due to chlorine. It is significant that the use of the metallic inorganic salt results in much less yellowing due to chlorine retention than the other accelerators under the same curing conditions.

Figure 32 shows the effect of time and temperature of cure on modified MF-treated fabric with regard to yellowing through 16 chlorine washings. In this case the yellowing due to chlorine with the metallic inorganic salt regardless of the temperature is hardly noticeable to the eye. There is very little yellowing with the alkanolamine hydrochloride. The yellowing with the ammonium salt accelerator is noticeable to the eye. It is interesting to note that the time of cure

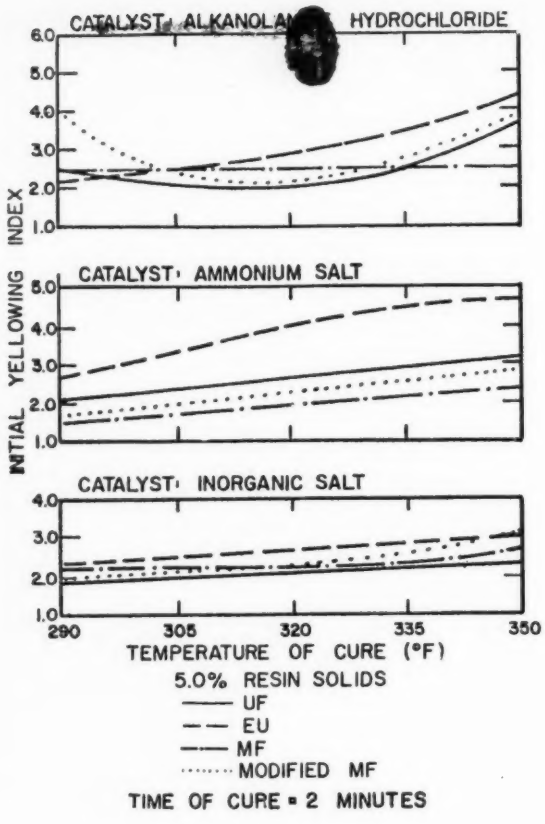

Figure 29
Effect of curing temperature on initial color of resin finishes

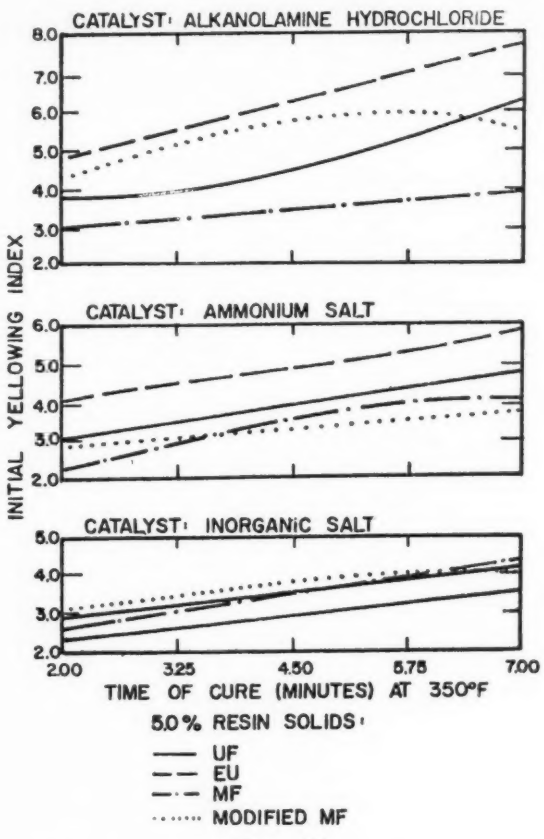

Figure 30
Effect of curing time on initial color of resin finishes

is not an important factor. In fact, with this type of resin, which has very good resistance to yellowing, even the temperature of cure has little affect on the degree of yellowing.

TEAR STRENGTH———A statistical analysis of the Elmendorf tear strength values showed that there was no correlation between this property and other factors such as wrinkle recovery and resin concentration. Furthermore, the tear-strength values were not reproducible. This lack of reproducibility apparently is due to the fact that the tear strength is influenced by other factors, such as stiffness, which varied with the application conditions. All the fabrics were, therefore, mechanically manipulated by dry tumbling to break down the stiffness and the tear-strength values redetermined.

After this treatment there was a correlation between tear strength and other properties; however, there are no large differences in the wrinkle-recovery and tear-strength relationships for the different systems studied. The wrinkle recovery is plotted against tear strength for the four "resin" finishes with the alkanolamine hydrochloride in Figure 33. As can be seen, the tear strength of the fabric decreases as the wrinkle recovery increases. All the "resin" finishes also show about the same relationship between these two properties with the other accelerator systems studied.

SUMMARY

A summary of the physical properties of the finishes studied is given in Tables V and VI.

The EU finishes generally have the highest wrinkle recovery for a given

TABLE VI
Fabric Properties

	Yellowing		
	Initial	After chlorine washing	Tear strength
Greatest	EU	MF	EU
↑	MF	Mod MF	UF
↓	UF	EU	Mod MF
Least	Mod MF	UF	MF

TABLE VII
Accelerator Rank

Best	Metallic inorganic salt
↑	Alkanolamine hydrochloride
↓	
Poorest	Ammonium salt

TABLE V
Fabric Properties

	Wrinkle recovery		Tensile strength		
	Initial	After chlorine washing	Initial	After chlorine washing	AATCC chlorine test
Greatest	EU	MF	MF	EU	MF
↑	Mod MF	Mod MF	UF	MF	Mod MF
↓	MF	UF	Mod MF	Mod MF	EU
Least	UF	EU	EU	UF	UF

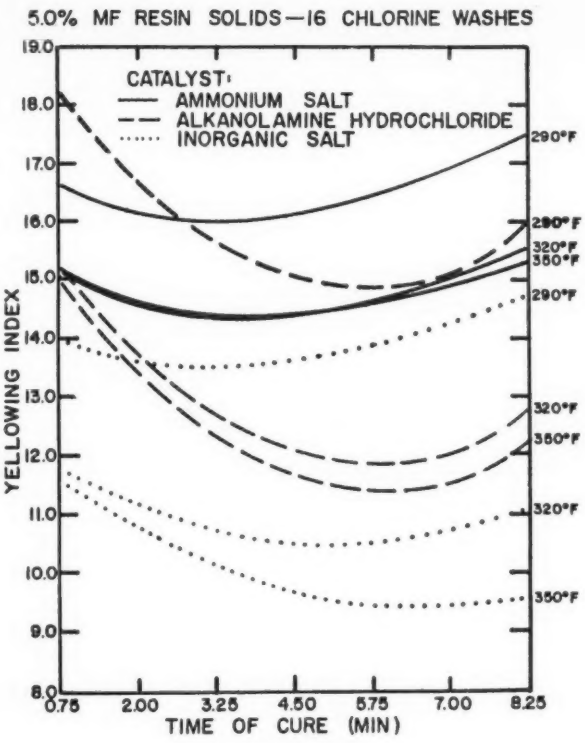

Figure 31
Effect of chlorine washing on yellowing of melamine-formaldehyde—accelerator systems

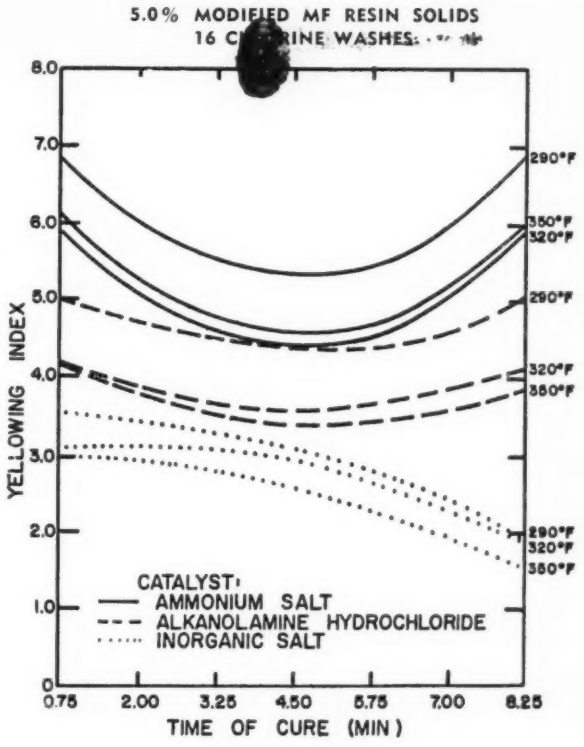

Figure 32
Effect of chlorine washing on modified melamine-formaldehyde—accelerator systems

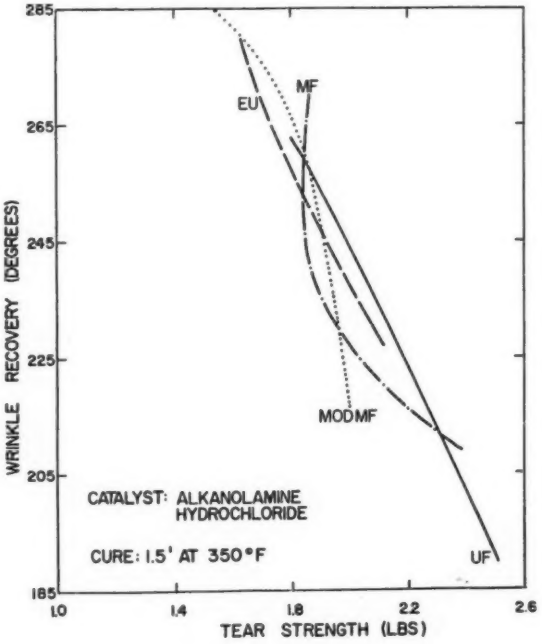

Figure 33
Relationship of tear strength to wrinkle recovery

"resin" solids, and the UF the lowest. The melamine finishes are intermediate with the modified MF equalling the EU under optimum curing conditions.

The retention of wrinkle recovery through chlorine washing of the melamine finishes is considerably greater than that of the EU or UF.

The MF and UF finishes generally have higher tensile strengths than those of the modified MF and the EU finishes for a given wrinkle recovery.

The EU-finished fabric generally shows a gain in tensile strength on continued chlorine washing. The melamine - "resin" - treated fabrics show little loss in strength on continued washings while the tensile strength of the UF-treated fabric decreases rapidly.

There is little loss in strength in the AATCC accelerated chlorine test with EU- and melamine-"resin"-treated fabrics that have been satisfactorily cured. With the UF-treated fabric most of the fabric strength was lost under these conditions.

The initial yellowing of the treated fabric during curing is generally greater for EU than with the others.

There is no yellowing of EU or UF and very little yellowing of the Modified MF-treated fabric during continued washing in the presence of chlorine, but MF-treated fabric does yellow.

There is little difference in tear strength for a given wrinkle recovery among the various "resin" finishes.

The ranking of the accelerators from best to poorest is given in Table VII.

Generally the metallic inorganic salt gives the highest wrinkle recovery, the least yellowing during curing, and the best retention of wrinkle recovery, least tensile loss and the least yellowing during chlorine washing of the accelerators studied. With this accelerator, high curing temperatures are required to obtain these superior properties. The alkanol amine hydrochloride generally provides fabric properties that are inferior to those of the metallic inorganic salt accelerator, but its optimum curing temperature is lower. The ammonium salt, in most cases, provides the least improvement in these fabric properties.

Although this summary gives general conclusions based on our study, it is recommended that the finisher carefully study the data contained herein to determine the best combination of resin-accelerator and curing conditions for the particular properties that he desires in the individual fabric that he wishes to treat.

ACKNOWLEDGMENT

The authors wish to acknowledge the aid of their associates in the American Cyanamid Co including: B J Barkousky, George De Paolo, L A Fluck, N J Glade, C Helfgott, E E Lineken, W N Nakajima and S J O'Brien.

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Nonwoven Fabrics———

(*Concluded from page P584*)

of the wet-finishing processes normally applied to woven fabrics. There are also several synthetic rubber and butadiene acrylonitriles, which, after curing, can impart similarly durable properties to a nonwoven fabric as cellulose xanthate.

DRYING AND FINISHING EQUIPMENT

The most common methods of removal of moisture from greige material include:

Dry cans
Hot air ovens
Infra red rods and lights
Calender rolls, and
High-frequency drying.

In most instances today, nonwovens are used in the greige. However, with some, the bonding agents demand curing and vulcanizing. Other heat-setting operations follow. With the advent of printed and finished nonwovens, other drying operations will be in order.

The finishing of a nonwoven fabric is a very important aspect. Much has been done to improve the finishing methods but much still remains to be done. Standard finishing techniques are not always the answer to lend desirable aesthetic qualities to a nonwoven fabric. New machinery and methods must be developed to utilize to the fullest those properties of a fiber which are incorporated in the nonwoven fabric. When the fibers can be utilized fully by correct fabric finishing, then the newer acrylic and polyester fibers will take their place along with the less expensive fibers.

USES OF NONWOVENS

Nonwovens are found in so many individual uses that to mention them all here would be disastrous. However, by grouping into types, the scope can pretty well be covered.

1) Toweling—disposable, reusable napkins, tablecloths.
2) Reinforcement for plastic films and coatings, to serve such needs as bookcloths, shoe linings, upholstery, etc.
3) Filtration, which would include industrial filters as well as milk and air filtration.
4) Cable wrapping—tapes of all descriptions. Some of the newer synthetic fibers have found a place here.
5) Clothing—blends of several fibers strengthened by the right bonding agent have found a market as fabrics. I have here on the table a nonwoven skirt fabric which has been washed at least six times and still has preserved its original properties. This is an indication of what can and will be done with nonwovens as new bonding and finishing techniques unfold within the industry. Note the porosity and wrinkle-resistant feature of this material.
6) Surgical field—batting, stretch bandages.
7) Industrial uses—electrical tapes, cords, labels, meat wrappings, polishing cloths, shoe fabrics, shoulder pads.

FUTURE

The future of nonwoven fabric is in the hands of the energetic textile producer. There is constant demand for new fabrics which offer better value than either a woven or paper product can offer. This will mean new developments in web-forming machinery, fibers, bonding agents, finishing equipment and techniques and the availability of these to the industry as a whole. I believe that, if the correct nonwoven fabric is engineered for the correct end use and becomes commercially acceptable insofar as performance and price is concerned, more challenges will be thrown up to the nonwoven industry. This has been the reason for its growth in the past ten years and will continue to be the reason for its growth in the future.

Amendments———

(Concluded from page P577)

tional Councilors representing that Region."

In third paragraph, insert "Executive" before "Secretary" to read:

" . . . by the Executive Secretary in the next available . . . "

Article VIII, Section 1

In first paragraph, insert "Executive" before "Secretary."

In second paragraph, insert "Executive" before "Secretary."

In third paragraph, insert "Executive" before "Secretary."

In fourth paragraph, substitute "received" for "returned" and insert "original" before "mailing" and "date" after "mailing" so that it will read:

"Affirmative votes on two-thirds of the ballots received within six weeks of original mailing date, and from not less . . . "

* * * *

The proposal seeks to clarify but not change the basis for determining membership qualifications, the procedure for handling ballots in the election of National Officers, and the terminology used in referring to Councilors representing Sections and the now Executive Committee on Research. Reference to the Secretary is changed to conform to the creation of the office of Executive Secretary. Provision is made for the offices of Executive Secretary, Treasurer and Chairman of the Executive Committee on Research to be held by separate individuals.

W A HOLST
Original Proponent

FUTURE PAPERS

"Dyeing Blends of Dacron Polyester Fiber and Cotton"—J J Iannarone, Jr, P L Speakman, O S Larson, R C Hurst, and E H Hinton, E I du Pont de Nemours & Co, Inc

"Cleaning Synthetic Fur Pile Fabrics"—Dorothy S Lyle, National Institute of Drycleaning

"Dyeing of Orlon Acrylic Fiber—Application of Cationic Dyes"—J P Neary and R J Thomas, E I du Pont de Nemours & Co, Inc

"Lighting Factors to be Considered in Textile Color Matching"—Warren B Reese, Macbeth Daylighting Corp

"Cross Index. I. Old *Colour Index* Numbers to New *Colour Index* Names and Numbers; II. Old Prototype Numbers to New *Colour Index* Names and Numbers; III. New *Colour Index* Names and Numbers to Old Names and Numbers"

AATCC Calendar

COUNCIL
Nov 14 (Lowell Technological Institute, Lowell, Mass); Jan 24 (New York, NY); May 23 (Philadelphia, Pa); Sept 19, 1958 (Piedmont area)

NATIONAL CONVENTIONS
Nov 14-16, 1957 (Hotel Statler, Boston); Oct 30-Nov 2, 1958 (Hotel Conrad Hilton, Chicago); 1959 (Sheraton Park and Shoreham Hotels, Washington, DC); Oct 6-8, 1960 (Sheraton Hotel, Philadelphia, Pa); September 28-30, 1961 (Buffalo, NY)

DELAWARE VALLEY SECTION
Sept 13 (Joint meeting with New York Section at Hotel Hildebrecht, Trenton, NJ); Nov 1 (Kugler's Restaurant, Philadelphia, Pa); Dec 6 (Kugler's Restaurant, Philadelphia, Pa)

MID-WEST SECTION
October 26 (Bismarck Hotel, Chicago, Ill)

NEW YORK SECTION
Sept 13 (Joint meeting with Delaware Valley Section at Hotel Hildebrecht, Trenton, NJ); Dec 6, Feb 7 (New York, NY); April 11 (New Jersey area)

NIAGARA FRONTIER SECTION
Sept 27 (Buffalo); Oct 25 (Joint meeting with CATCC Ontario Section at St Catherines, Ont); Dec 6, Feb 21 (Buffalo); Apr 4 (Joint meeting)

NORTHERN NEW ENGLAND SECTION
Sept 13 (Outing—Wachusett Country Club, W Boylston, Mass); Dec 6 (Annual meeting, Hotel Continental, Cambridge, Mass)

PIEDMONT SECTION
Sept 27-28 (Annual Meeting—Hotel Barringer, Charlotte, NC)

RHODE ISLAND SECTION
Sept 27 (Ladies Night—Narragansett Hotel, Providence, RI); Oct 24 (Providence Engineering Society, Providence, RI); Dec 5 (Annual Meeting—Johnson's Hummocks Grill, Providence, RI)

SOUTH CENTRAL SECTION
Sept 20 (Hotel Patton, Chattanooga, Tenn)

SOUTHEASTERN SECTION
Sept 13 (Harmony Club, Columbus, Ga); Dec 7 (Atlanta Biltmore Hotel, Atlanta, Ga)

WESTERN NEW ENGLAND SECTION
Sept 27 (Rapp's Restaurant, Shelton Conn); Nov 1 (Annual meeting, Hartford, Conn. area); Dec 13 (Rapp's Restaurant, Shelton, Conn)

NOTE

The date of the joint meeting of the Delaware Valley and New York Sections, originally scheduled for September 27th, has been moved up to September 13th. The site of the meeting—the Hotel Hildebrecht, Trenton, N J—remains the same.

MEMBERSHIP APPLICATIONS

SENIOR

William E Driscoll—Salesman, Borden Co Chemical Div, New York, NY. Sponsors: L Shapiro, R H Gavitt. (NNE).

Paul B Dry—Overseer, Mooresville Mills Div of Burlington Industries, Mooresville, NC. Sponsors: W D Moss, Jr, R H Baker, Jr. (P).

Robert F Lachance—Overseer of dyeing, Pepperell Mfg Co, Biddeford, Me. Sponsors: D H Thomas, J Weirman. (NNE).

Ralph D Morrison—Tech asst, E I du Pont de Nemours & Co, Inc, Wilmington, Del. Sponsors: B F Faris, G M Richardson. (DV).

Maurice W San Souci—President, Norwalk Dyeing & Finishing Corp, Norwalk, Conn. Sponsors: A J Rooney, M Gordon. (WNE).

JUNIOR

Wendell Borne—Chief dyer, Pittsburg Knitting Mills, Inc, South Pittsburg, Tenn. Sponsors: A R Williams, J C Whitt. (SC).

William B Luce, Jr—Textile research, Dyecraftsmen, Inc, Hingham, Mass. Sponsors: A W Mack, W B Luce. (NNE).

Troy B Terry—Testing supv, Collins & Aikman Corp, Albemarle, NC. Sponsors: S G Hasty, G R Currier. (P).

Bob A Worley—Chemist, Joseph Bancroft & Sons Co, Wilmington, Del. Sponsors: A L Lippert, R S Babiarz. (DV).

ACTIVITIES OF THE LOCAL SECTIONS

Niagara Frontier

THE 3rd Annual Outing of the Niagara Frontier Section was held June 21, 1957 at St Catherines Golf Club, St Catherines, Ontario, Canada.

Approximately thirty members and guests participated in the golf tournament, after which more than fifty members and guests attended dinner.

Awards were made to N J Mohoruk, who carded low gross in the golf tournament, and John Reagan, who took low net honors. Mr Mohoruk also received the AATCC Plate Award.

Several members won prizes as a result of a drawing held after dinner.

NEW YORK SECTION OUTING • JUNE 21, 1957 • NORTH JERSEY COUNTRY CLUB, PREAKNESS, NJ

(See report on page P514 of July 15th issue)

(Courtesy of Louis J Dogin, Brook Chemical Co)

News of the Trade

Smith, Drum Bought by Turbo

Turbo Machine Company, Lansdale, Pa, has purchased the business of Smith, Drum & Co, Philadelphia, one of the country's oldest manufacturers of textile dyeing and finishing machinery.

Inventory and work in progress are being moved to the Turbo plant. Some of the key sales and production personnel are joining the Turbo organization. The Smith, Drum plant, at 4th Street and Allegheny Avenue, is retained by the present owners.

Smith, Drum sales are reported to be over 1½ million dollars annually. Their products include hosiery and sweater dyeing machines, skein and raw stock dyeing machines, high-pressure dyeing equipment for package and beam dyeing.

Turbo Machine Company makes the Turbo preboarding machine for the hosiery industry, heat-setting machines for synthetic fibers, staplers and crimpers for synthetic fibers, sweater setting machines and finishing machines for the high pile trade and the woolen and worsted industry.

OBSW Names Canadian Distributor

Original Bradford Soap Works, Inc, West Warwick, RI, has announced the appointment of Mohawk Chemicals Ltd, P O Box 61, Mt Royal Station, Montreal 16, P Q, Canada, as distributors for its textile auxiliaries, including polyethylene-type finishing compounds, Bradsyn detergent solvents, and other special chemical products as well as its technical service.

Mohawk Chemicals Ltd will provide regular coverage of the area and will maintain stocks in both Quebec and Ontario.

NYPC Fall Meetings

The New York Pigment Club has scheduled the following lectures for the first two meetings of the Fall season:

Sept 12—"Pigmenting Thermoplastic Resins," Robert Snediker, Bakelite Div, Union Carbide Chemicals Co.

Oct 10—"Rare Earth Elements in Pigments," Arthur Linz, consultant.

Both meetings will be held at Fraunces Tavern, Broad & Pearl Sts, New York, NY, at 6:30 pm.

SCP Celebrating 35th Anniversary

Standard Chemical Products, Inc, Hoboken, N J, and Charlotte, N C, is celebrating this month the 35th anniversary of the founding of the Company.

Standard Chemical was incorporated in August, 1922, by Louis Grombacher as president and Max Einstein as vice president for the manufacture of products for the textile industry. The present plant in Hoboken was built in 1925, while the Charlotte plant was constructed and put into operation in 1954.

The 35th anniversary was formally observed by a week-long meeting of the sales and executive personnel at the Charlotte plant and offices. In addition to the business sessions a dinner honoring Mr Grombacher was held at the Charlotte City Club. The annual Company golf tournament, which concluded the meeting, was won by Ed Pickup, manager of the Charlotte plant with John Bloetjes, Metropolitan New York sales representative as runner-up.

GAF's New Surfactant Plant on Stream

Full-scale operation of General Aniline & Film Corporation's new surfactant plant at Calvert City, Ky, is now underway.

The new installation occupies part of the 55-acre tract where General Aniline's new high-pressure acetylene chemicals plant is located. Products being produced in this new multi-million pound surfactant facility are alkylphenols and Igepal and Alipal type surfactants.

The new plant is part of an expansion program which includes additional capacity at the Company's surfactant plant in Linden, NJ, and the establishment of a large storage tank farm at Alameda, Calif. Bulk nonionic surfactants are being transported by ship from Linden to California.

In addition, the Company is constructing at Linden an ethylene oxide-ethylene glycol plant with a total capacity of 60 million pounds a year. Ethylene oxide is reacted with alkylphenols to form nonionic surfactants of the Igepal type. Further chemical treatment of the Igepals produces Alipals.

Dan River to Construct New Research and Chemical Plant

Dan River Mills, Inc, plans to construct a new research and chemical manufacturing plant on a 13-acre tract just outside the city limits of Danville, Va, it is learned. Negotiations have virtually been completed with the Danville Industrial Development Corporation for the purchase of the land.

Tentative plans call for a two-level building with about 50,000 square feet of floor space. The building will be used in part for expansion of the company's long-established research facilities, and in part for the manufacture of various chemicals required in Dan River's manufacturing and finishing operations.

H Y Jennings, director of research, stated in connection with the announcement: "The need for additional space for research and chemical manufacturing has been apparent for more than a year. With the increased demand for fabrics with our Wrinkl-Shed finish, and more recently, our new minimum-care finish, Wrinkl-Shed with Dri-Don, existing facilities for manufacture of these resin finishes and other chemicals are no longer adequate."

He added that, with the space and equipment to be available in the new plant, the company would be able to expand its manufacture of chemicals to meet increased requirements in both greige manufacturing and finishing. He also indicated that a modest increase in personnel would be necessary, once the new plant is in full operation. Additional employment would be largely on chemical manufacturing, he noted, with the research staff to remain at about the current level for the time being.

HRL Cooperating in Teacher Program

The Harris Research Laboratories, Inc, Washington, D C, are again this year cooperating with the Chemistry-Physics Teachers Institute under the sponsorship of the National Science Foundation. Four high school science teachers are participating in the program.

The teachers are gaining familiarity with textile chemical research methods by actively participating in the various textile research and development activities carried on at HRL.

• NAMES IN THE NEWS •

Draper

The appointment of **Neal M Draper** as assistant to the executive vice president of National Aniline Division, Allied Chemical & Dye Corporation, has been announced. Mr Draper has been assistant director of sales with Allied's Solvay Process Division.

Mr Draper's broad experience in sales and management covers twenty-two years with Allied in the Solvay Process Division.

Taylor

Ralph E Taylor has been appointed branch manager for Wica Chemicals, Inc, in Columbus, Ga. Headquarters of the company is in Charlotte, NC.

In his capacity as branch manager, Mr Taylor will serve the three-state area of Alabama, Georgia and Tennessee. His services will include special attention to the chemical problems of textile mills and paint manufacturers.

Before joining Wica, Mr Taylor was associated with the Borden Company.

P J Wood, technical director of Royce Chemical Co, Carlton Hill, NJ, and recently named Olney Medal winner for 1957, was elected a Fellow of the Society of Dyers and Colourists at the Society's July Council meeting.

The Fellowship is conferred on senior members of the Society who have attained high standing in the knowledge and practise of tinctorial technology.

Saalfrank

Durheimer

Sandoz, Inc, has announced the appointment of **Charles W Saalfrank** as assistant technical director of its Dyestuff Division. **Otto P Durheimer** succeeds him as chief chemist of the Company's New York Application Laboratories.

Mr Saalfrank, secretary of the Pleating Committee of AATCC's Technical Committee on Research, has been with Sandoz for sixteen years.

Mr Durheimer came to Sandoz in 1953 from Beattie Mfg Co.

Leonard Smith, director of the National Cotton Council's utilization research division, will serve as vice chairman of the Gordon Research Conference on textiles in 1958.

Lederer

James W Lederer, formerly in the Chattanooga office of Richmond Oil, Soap & Chemical Co, has been discharged from the U S Air Force. He will head the Company's new Southern office at 509 S Lindell Rd, Greensboro, NC.

Recent winners of scholarships at Clemson College include **Ervin R Poole** and **Henry F Cooper**, $1200 Owens-Corning Fiberglas scholarships; **Henry H Perkins** and **William J Allred**, $1000 Blackman-Uhler scholarships; and **Robert H Barker** and **Donald H Logue**, $1000 Ciba scholarships.

Watson

Glenn S Watson has been named technical director of American Cyanamid Company's Organic Chemicals Division. With Cyanamid since 1936, Dr Watson has served as resident technical director for the Marietta and Willow Island plants of the Company since 1950. In his new position he will make his headquarters at Bound Brook.

* * *

Establishment of a sales and merchandising organization for the marketing of Creslan, American Cyanamid's acrylic fiber, was announced July 31st.

Managers of four departments which will serve the new fiber's principal end-product areas are **Charles D Reich**, manager of sales and merchandising to the woven goods field; **George P Vescio**, manager of sales and merchandising to the knit goods field; **William G Fash**, manager of sales and merchandising to the home furnishings field, and **Ivan Y T Feng**, manager of export and special product sales.

At the same time, it was announced that **R J G Schofield** has been named manager of technical service, heading a department which will serve Creslan customers in all segments of the textile industry.

The newly created sales and merchandising and technical service departments will report to **W L Lyall Jr**, general sales manager for the Fibers Division.

A broad marketing program for the introduction of Creslan in a wide range of end-uses is now being developed. The centralization of sales and merchandising in each general end-product area under an expert in that field is part of this program. More than ten years in development, Creslan will be produced in Cyanamid's new Santa Rosa Plant, now under construction near Pensacola, Fla.

Vatclear Concentrate

Metro-Atlantic, Inc, Centredale, RI, has announced what it considers to be an outstanding achievement in the vat printing field—a printing emulsion which reportedly has proven 100% stable under all production conditions.

The product reportedly was perfected over a year ago, following some four years of laboratory research, experimentation and test; but announcement has been withheld until now so that it might be subjected to still another year of rigorous practical application by one of the largest printing and finishing companies in the field. It is reported that more than two million yards of cloth have been successfully printed with this new technique. Complete control of vat printing is said to be possible through every stage of processing. It is claimed that the product has demonstrated complete stability to electrolytes and has reduced or eliminated seconds and losses in production time due to interruptions which were normal with the use of conventional starch, paste or gums. Important savings reportedly have been made in this category, and in the use of the actual vat dyestuffs.

Metro-Atlantic points out that, fairly recently, similar products have been introduced both in this country and abroad which might be stable for a couple of hours, but not long enough to withstand the complete cycle of processing. The Company emphasizes that the new emulsion has unlimited stability to storage, does not breakdown during use, and will accept electrolytes commonly found in dyestuffs, alkalies, and reducing agents. It is further stated that the emulsion itself can stand for long periods, without forming a crust, and may be used over again. Emulsion which has been standing for six months is as good as it was originally, it is claimed.

The new emulsion product, to be trademarked Vatclear Concentrate, is composed of water, solvent, stabilizers, emulsifiers, and a specially developed protective colloid. From the Vatclear Concentrate, the printing emulsion is said to be easily prepared. It contains no resin.

Among the points offered by Metro-Atlantic to show some of the ways this product may be used advantageously on a production basis are the following:

1) The emulsion requires no special equipment for its use. In fact, in some instances, equipment can be reduced, while production is speeded up.

2) Elimination of starch, paste and gums will eliminate a great deal of labor cooking up the vehicle for the color, and also cut down on storage space requirements. The Vatclear printing emulsion can be prepared cold in minutes and requires no cooking.

3) In printing, viscosity of the print paste is a vital factor in the uniform reproduction of patterns. Those who have been using the new emulsion say it has never been necessary to thin it or thicken it at any speed, and that the same reproduction of pattern is obtained throughout a run as long as 100,000 yards.

4) Containing no solids and being a natural lubricant, the new emulsion deposits no film on the doctor blades that press against the rollers. The use of the discharge clear emulsion for printing vat discharges eliminates facing, snaps, and streaks.

5) Of interest to the textile designers interested in print applications, better designs and fineness of detail may be achieved at high rates of printing speed with sharpness of mark and absence of flushing, as the emulsion has excellent flow properties.

6) After printing and drying, the fabric need not be aged immediately since the printed area has unlimited stability.

7) In the aging process, an increase in ager speed up to 25% has been achieved. Also, the moisture in the ager can be practically eliminated, as there is no film present in the printed areas.

8) Further equipment reduction may be realized in the usual oxidizing and washing operations following aging. With emulsion, it is claimed, 40,000-50,000 yards of fabric have been washed and the water is still clean and reusable. One plant which formerly used 8 to 10 boxes in its washer now needs only a 3 to 4 box washer when using the new emulsion printing. Less color waste therefore partially accounts for a part of an increase in color value.

9) Vatclear emulsion offers no barriers to resin penetration in printed areas when resins are used to produce crease resistance, dimensional stability, or drip-dry quality.

It is felt that with the important increase in color value and lessening of plant operations offered, the use of vat colors in printing may be made competitive costwise with methods using colors of poorer quality.

Maxilon* Dyestuffs

A new series of fast basic dyestuffs for Orlon and other acrylic fibers has been inaugurated by Geigy Dyestuffs, Division of Geigy Chemical Corp, Ardsley, NY.

The first member of this series to be offered is called Maxilon Blue GLA, which reportedly produces deep blues on Orlon with outstanding fastness to light (rating of 7-8). Rating 7 in even very light shades, Maxilon Blue GLA is faster to light than any blue yet offered for the coloring of Orlon, it is claimed.

Maxilon Blue GLA also is said to give on all fibers for which its use is recommended maximum or near maximum fastness to washing, perspiration, fulling, wetcleaning, sea water, water bleeding, carbonizing and drycleaning.

Along with the Maxilon series, Geigy has developed a new dyeing procedure which, it is stated, will produce extremely level, reproducible shades and minimize greatly the amount of redyes necessary. Due to the varying affinity of Dynel, Acrilan, Verel and Darlan, the fibers for which the new series is recommended, the new dyeing method must be altered according to the specific fiber being dyed. The new method can also be used with the older basic colors as well as with the special basic type made by manufacturers other than Geigy. Details will be furnished by the company on request.

According to Geigy, no competitive product has a shade cast similar to Maxilon Blue GLA, being either decidedly redder or greener.

In the near future, Geigy will add another shade of blue and a red to the line, which eventually will cover the spectrum.

*Registered trademark

Ban Scour; Scourpen 1611; Rosoft

Richmond Oil, Soap & Chemical Co, Philadelphia, Pa, has introduced three new products of interest to the outerwear trade.

Ban Scour is a liquid soap with solvent properties designed primarily for the cold or prescour of Ban-Lon and other textured yarns. It is said to do an efficient job of removing coning oil and dirt, giving a whiter fabric with improved bulking characteristics. It may also be used in

the final scouring and dyeing operation.

Scourpen 1611 is a nonionic surfactant designed for the washing of Shetland, lamb's wool, cashmere and wool blend sweaters. It is said to remove oils and greases readily and leave a soft, lofty hand. Being on the acid side, it reportedly will not change the color of the yarn.

Rosoft is a cationic softener designed to give a soft, luxurious finish on Shetland, lamb's wool, cashmere and wool blend sweaters. It reportedly will not darken at temperatures up to 300°F.

Graphic Arts China-Luxe Grey

Sun Chemical Corporation has announced the development of a completely neutral grey paint for use in printing plants and experimental laboratories where color tests are being conducted. The new paint, called Graphic Arts China-Luxe Grey, resulted from joint studies by two Sun Chemical divisions, the General Printing Ink Co and A C Horn Co, Inc.

When measured spectrophotometrically, surfaces finished with the new paint are said to show virtually linear response to all wavelengths in the visible spectrum, thereby holding distortion of a color under observation to an absolute minimum. The overall reflectance has been established at approximately 60%.

Graphic Arts China-Luxe Grey is now available in three finishes—flat, semigloss and enamel—so that walls, trim and equipment may be covered with the appropriate reflective surface. It will be sold on a custom basis, rather than carried as a stock item.

Requests for additional information about the product and its applications should be addressed to: A C Horn Co, Inc, division of Sun Chemical Corporation, 10-10 44th Ave, Long Island City 1, NY.

Co-Wax

Co-Wax, a new product announced by Concord Chemical Co, PO Box 800, Camden, NJ, is said to form a completely stable Carnauba-type water-wax emulsion when it is added to hot water. It is claimed that a uniform emulsion is guaranteed every time, which is light-colored, translucent, and has fine particle dispersion. This water-wax emulsion reportedly requires a minimum amount of stock and preparation, yet guarantees a fine, stable product.

Cross sectional view Phillips Exacto Rotary Joint

Exacto

The design of the new Phillips Exacto rotary joint is said to offer unusually long service life on such textile equipment as can dryers, palmers, calender rolls, embossers, slashers, etc.

This unit is claimed to be the first of its kind which guarantees to eliminate seizing or freezing on the roll. The standard unit reportedly operates at steam pressure up to 250 psi, with temperatures up to 500°F and speeds up to 1000 rpm.

Other reported features include simplicity of construction, flexible shaft alignment, packless and self-lubricating bearing surfaces, with a new low minimum turning torque. The internal pressure relief design also is said to allow the sealing members to function independently of the operating load.

A complete range of sizes is available in ½" through 1½" in both the TF and S types. A detailed catalog is available from Phillips Sales Co, PO Box 417, West New York, NJ.

Crestolan Concentrate

Crest Chemical Corporation, 225 Emmet St, Newark, NJ, has announced the development of Crestolan Concentrate, a new nonionic surfactant for use in the scouring and processing of wool, rayon, cotton, nylon, Orlon, Dacron and Acrilan. This product is said to combine the powerful detergency of soap and the excellent wetting, chemical stability, and hard-water resistance of nonionic ethers.

Crest Chemical recommends the product for improved kier boiling, faster desizing, increased absorbency, more efficient bleaching, and improved sweater and knitwear scouring and dyeing.

It is claimed that Crestolan Concentrate does not cloud in a boiling bath, so that optimum detergency is obtained at all temperatures. It is said to be stable to strong acids and alkalies, to be compatible with anionic and cationic-active agents, display exceptional wetting efficiency particularly in alkaline solutions, and to rinse completely free from all fibers.

New Process for Chromyl Chloride

A patent covering a new process for production of chromyl chloride has been obtained by Allied Chemical & Dye Corporation. The process is described in US Patent 2,793,937.

Developed by the Mutual Chromium Chemical research specialists of Allied's Solvay Process Division, the process features use of the end product as the reaction medium. In practice the reactor is charged with chromyl chloride set aside from a prior run.

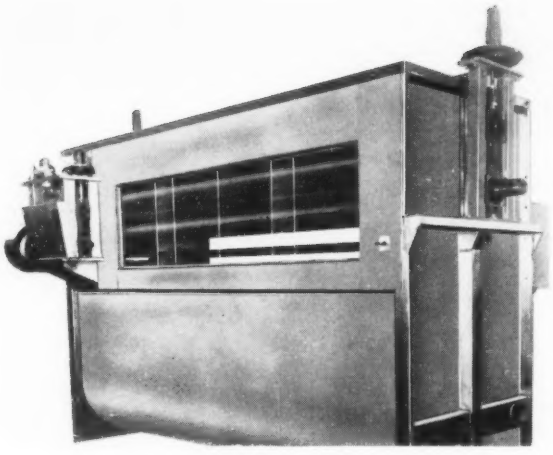
Since the first announcement of chromyl chloride as a pilot-plant product in 1955, the price has been reduced to about one-third of that at which it was first offered. Chromyl chloride is now being shipped in ton lots.

In addition to its potential usefulness in carrying out homogeneous organic oxidations and chlorinations, chromyl chloride has found use in the manufacture of coordination compounds of trivalent chromium. Many of these compounds have unique surface-modifying properties imparting water and oil-repellency to textiles, paper, leather and plastics. They may be used in making glass fiber laminates. Chromyl chloride is also a potential intermediate for preparation of various organic compounds of chromium, including aryl chromiums and organic chromates.

Chromyl chloride reportedly dissolves chromic acid (CrO_3) and this solution is a vigorous oxidizing agent, igniting many hydrocarbons, alcohols and amines.

In spite of its reactivity, chromyl chloride is said to be capable of being readily handled and stored. The high purity of the material produced by the new process is said to impart complete stability and noncorrosiveness to most metals as long as light and moisture are excluded. It is currently shipped in ICC-approved 85- and 200-pound stainless steel drums, and has a reported purity of over 98%.

Samples, technical data sheets and other information may be obtained by writing to Mutual Chromium Chemicals, Allied Chemical & Dye Corp, Baltimore 31, Md.



Cook Washomatic

Washomatic Rope Washer; Rotomatic Steamer

Cook Machine Co, Nashua, NH, has introduced a new washer, to be known as the Washomatic, for processing cloth in the rope form. The first three of these are in operation in a new Cook Continuous Rope Bleaching Range of the Du Pont type in a midwestern finishing plant,which reportedly is handling fabrics weighing from 1½ to 6 yards per pound at high rates of speed. The washer has patent-applied-for features, which are said to permit the washing or processing of cloth of any weight at any desired degree of automatically maintained tension. It is claimed that wash tests conducted by Du Pont's Electrochemicals Dept show the Washomatic to be superior in washing efficiency while requiring a minimum volume of water.

A new idea for retention of open-width cloth in a steam atmosphere has resulted in the introduction of the Rotomatic by Cook Machine Co. The machine is claimed to require only half the floor space and cost only half as much to manufacture as conventional conveyor equipment, and reportedly will store cloth without excessive weight and free from rub marks. It is stated that cloth is not disturbed after being loaded into the Rotomatic and is withdrawn at delivery side freely and without drag.

Polysize NS; Nyl-Scour ASD

Aquex Development & Sales Corp, Whippany, NJ, has introduced two new products of interest to the textile yarn processing and fabric industries.

Relative to yarn processing is a new type of water-dispersible polyethylene multimolecular size for synthetic yarn sizing, which is said to be particularly suited for Dacron filament yarns of various denier of both high and low twist. This product, Aquex Polysize NS is said to circumvent any further need of after-waxing, thereby effecting a large saving in time and chemical cost. Polysize NS reportedly contains within its structure such components as antistatic features and required lubricants, as well as a built in surface-active action to further uniformity of yarn coverage. Polysize NS is said to be readily removed with ordinary scouring methods. Averaging 97%-98% loom efficiency, Polysize NS has been proven to practically eliminate fuzzing, balling, and shedding in process of weaving and has also greatly reduced soiling of cloth due to static deposits, it is claimed.

Aquex has introduced to the fabric processors a newly developed nylon bleach and scouring chemical compound, Aquex Nyl-Scour ASD, to assist the dyer in overcoming excess yellowing of nylon fabrics. It is claimed that Nyl-Scour is integrally compounded to contain within its structure solvent-active components and emulsifiers so as to remove fat, oils. and waxes used in most sizes which have a tendency to decompose, causing excessive yellowing. Nyl-Scour is also said to help maintain greater fabric tensile strength, inasmuch as this product does not adversely affect the recurring amide groups in long-chain molecular structure of nylon. With the use of Nyl-Scour, it is stated that most nylon fabrics can be processed without additional conventional bleaches. Nyl-Scour reportedly is suitable for use in dyebeck or jig and does not require special handling.

TECHNICAL LITERATURE

(It is understood that the following literature is available from the sources listed in italics).

THE CHEMISTRY OF FATTY AMINES———*Armour & Co, Chemical Div, 1355 W 31st St, Chicago 9, Ill*——— Fatty amines, what they are, how they are made and what they will do, are discussed in this booklet.

Described as organic bases made from fatty acids, the fatty amines are recent graduates from the research laboratory and new uses are still being found for them.

The booklet covers synthesis of fatty amines, saturated and unsaturated fatty amines, vapor pressure, solubility and handling of the chemicals.

Long-chain alkyl quaternary ammonium salts are touched on as are some of the quaternary ammonium compounds formed from them. The booklet is complete with chemical equations and tables showing various reactions.

SPECIFICATIONS FOR FINISHED PAPER FIBER FABRICS, FINISHED WOVEN SARAN FABRICS AND FINISHED COLORED RAYON FABRICS USED IN AUTOMOBILES AND OUTDOOR FURNITURE ——— *Monofilament Automotive and Outdoor Furniture Fabric Weavers Group, The National Federation of Textiles, Inc, 389 Fifth Ave, New York 16, NY*———The Specifications, intended to be used by buyers and sellers of these fabrics, include description of test methods, inspection specifications, definition of defective material, defect allowances, definition of quality classifications and inspection conditions.

EXSIZE-T — THE PERFECT DESIZER FOR THE TEXTILE INDUSTRY ———*Pabst Brewing Co, Merchandise Mart, Chicago 54, Ill*———Features of this second edition include a discussion of properties of Exsize-T desizers; sections on Assay Procedure, Temperature, pH, Recommended Amounts, Storage Stability, and Inactivation of Enzymatic Action; and a list of penetrants found to be compatible with Exsize-T. The latter gives the trade names of the penetrants, both percentages, and sources.

SCHMIEG VERTICAL ROTOR TYPE DUST AND FUME ELIMINATORS ———*Catalog VRU-4-57, Schmieg Industries, Inc, P O Box 4701, Detroit 34, Mich*———This illustrated catalog discusses how centri-merge vertical rotor units operate and lists operating advantages and maintenance features. Also included are designs, sizes and dimensions for both the manual cleanout and the conveyorized cleanout types.

Abstracts

(Concluded from page 576)

dye liquor to circulate more around the edges of the carpet than the middle parts. Another factor is the greater difficulty of maintaining an even temperature throughout a large dyebath, which may vary as much as 20°F between points nearest to and furthest from the steam inlet.

To remedy these conditions, the author recommends the use of covers for the dyeing machines to maintain a more uniform temperature, and rapid circulation of the dye liquor from the bottom of the bath back to a central point within the folds of the fabric.

The direct dyes used for this purpose are selected mainly for their fastness to light. For salt-sensitive dyes a special dyeing method is suggested.

Dyes containing copper should not be used, since this metal promotes degradation of the rubber backing of the carpeting.

It is generally desirable to leave the dyed rayon carpet in either a neutral or slightly acid state, and this may be achieved by aftertreatment with acetic acid, aluminum acetate or alum.—WHC

The Backing of Tufted Carpets with Compounded Rubber Latex

Wallace, B A, and Reynolds, E J P, *Man-made Textiles* **34**, No. 397, 72, 75, June, 1957.

The principal function of the rubber backing on tufted carpets is to bond the pile of the carpet, but it also serves to give increased weight and improved handle to the finished product. Furthermore, rubber-backed carpets may be cut without fraying. The backing obtained with a suitably prepared latex compound is both flexible and waterproof.

The basis for almost all backing compounds at present used in England is natural rubber latex, which is compounded with other materials, largely mineral fillers such as whiting, china clay or barytes. Compounded rubber latex may be applied to tufted carpets by a method very similar to the standard back-sizing process used in the carpet industry. The machines for this purpose and the application of the latex to the carpet are described.

The most efficient method of drying rubber-backed tufted carpeting is by passing it through a hot-air dryer which may be heated by steam, electricity, gas or oil. Alternatively, the carpet may be passed under infrared heaters or over heated steam coils, or a combination of both. In either case the heat must be regulated. Drying at too high a temperature will cause blisters and will make the backing porous.

Cut pile carpets will require a dry weight of 16-25 oz of latex compound per sq yd. Loop pile carpets will require more (20-30 oz per sq yd) in order to anchor the pile effectively.—WHC

The Yellowing of Nylon

Steiger, F H, *Textile Research J* **27**, 459-65, June, 1957

White nylon tends to become yellow during curing and heat-setting operations as well as during consumer use. This appears to be true, no matter whether the fabric has been finished to achieve special effects such as stiffness or has been allowed to pass with a minimum of finishing agents. However, treatment of nylon with thermosetting resins definitely increases the tendency of nylon to yellow when heated. The author offers experimental evidence to show that the terminal amine groups of the fiber are involved in this discoloration.

To prevent the tendency of white nylon to become yellow when heated, experiments were made with urea, which theoretically should react with the terminal amine groups. Nylon cloth was padded through a water solution containing 30% urea, dried, and cured at 300°F, then rinsed free of unreacted urea, and dyed with Alizarine Sapphire BN (*CI* 63010), which is said to dye only the primary amine groups. The nylon so treated dyed very much lighter than untreated nylon, indicating that the amine groups had been partially blocked by the urea. The urea-treated nylon, on heating, was found to have considerably less tendency to yellow than the untreated fabric.

Further experiments indicated that dull nylon takes longer to yellow than bright or semi-dull nylon; also the composition of the fiber polymer affects the rate of discoloration; eg, Rilsan (a polyamide 11) turns yellow more rapidly than nylon 6,6.

Patent applications on the treatment of polyamides with urea have been filed.—WHC

Some Observations on the Dyeing of Dicel and Tricel Yarns and Fabrics

Olpin, H C, and Wood J, *J Soc Dyers Col* **73**, 247-57, June, 1957

The authors explain that Dicel and Tricel are the registered trademarks of British Celanese Ltd for secondary acetate and triacetate, respectively.

In general, Tricel resembles secondary acetate in behavior, but it is more hydrophobic, and more difficult to saponify and to deluster. It is dyed with disperse dyes, the majority of which dye at much slower rates and do not achieve such high saturation values. It is also thermoplastic, and by suitable heat-treatment can be set, in the sense that it is then much less readily softened by heat or water, a property which it shares with the nylons and Terylene. X-ray diffraction photographs show that this thermosetting is due to increase in the crystallinity of the fiber.

Effects produced on Tricel textiles by hot-embossing, hot-pleating, and similar treatments are very much more resistant to removal by washing than similar effects produced on secondary cellulose acetate textiles.

Full colors are obtainable on Dicel and Tricel with disperse, azoic, and developed dyes. A carrier technique, no longer considered necessary for Dicel, is valuable for Tricel, for which high-temperature dyeing also can be used. Azoic combinations, applicable to both fibers by the concurrent technique, show variable resistance to permanent change of color on ironing. Some combinations are substantially free from this trouble, but in all cases where it takes place it is associated with change in the degree of aggregation, which suggests redispersion of the dye aggregates in the fiber.

The authors give a list of disperse dyes having superior fastness to thermosetting on Tricel. They state that, for navy blues and blacks, developed dyeings are more satisfactory than direct dyeings. Blacks can be obtained with a limited number of bases, which can be applied, diazotized and developed sequentially as on Dicel.

The authors describe some work that they have carried out on the aggregation of azoic dyes on both Dicel and Tricel, and in particular, an investigation of the behavior of Fast Red B base on Tricel, showing how uptake of this base varies with temperature and concentration. They state that a number of manufacturers now market azoic diazo components and arylides of 3-hydroxy-2-naphthoic acid and similar hydroxy-carboxylic acids ready-mixed for application by the concurrent process (ie, applying both components together in an aqueous dyebath, followed by diazotizing and simultaneous coupling). These mixtures so far appear to be of European origin.—WHC